

***SECTION VI***

***GROUNDWATER AND LEACHATE MONITORING PLAN***

*Prepared for*  
**Waste Management of Hawaii**

**GROUNDWATER AND  
LEACHATE MONITORING PLAN  
WEST HAWAII SANITARY LANDFILL  
WAIKOLOA, HAWAII**

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## 1. INTRODUCTION

This revised Groundwater and Leachate Monitoring Program Plan (hereinafter, "Plan") presents an updated groundwater and leachate monitoring program for the West Hawaii Sanitary Landfill (WHSL). Geosyntec Consultants, Inc. (Geosyntec) in collaboration with GeoChem Applications prepared the Plan on behalf of Waste Management of Hawaii (WMH). The Plan contains information on WHSL operations and background, regional and local geology and hydrogeology, and the proposed monitoring program for groundwater and leachate.

### 1.1 Site Background

The WHSL is an active municipal solid waste landfill on the northwest side of the Island of Hawaii (Figure 1). Operation of the landfill began in 1993. The facility is owned by the County of Hawaii Department of Environmental Management and operated by WMH. The WHSL landfill is located between the Queen Kaahumanu and Mamalahoa Belt Highways, approximately 6,600 feet inland from Pueo and Keawaiki Bays. The entire facility covers approximately 300 acres. The permitted waste footprint is basically square and covers approximately 150 acres. The administration building, scale house, and maintenance shop are located at the northern end of the facility, near Queen Kaahumanu Highway (Figure 2).

The site is situated on the Lava Flow of 1859 from the Mauna Loa volcano (Figure 3) and older flows including the Kaniku Lava Flow. The lava flow consists of basalt with little ash cover. Both types of lava, a'a and pahoehoe, are found at the site. Geological investigations indicate fractured basalt exists below the surface a'a lava. The geology beneath the WHSL consists largely of hard, gray vesicular basalt (fractured bluerock). Thin intermittent layers of reddish gray basalt fragments (clinker) lie widely spaced between the dense bluerock layers. Lava tubes, holes, and large cracks are known to exist in the region. The shallow groundwater aquifer beneath the WHSL occurs within the underlying sequence of fractured basalt flows and clinker. .

Groundwater monitoring was conducted at the site on a quarterly basis from 1993 through 1995, and on a semi-annual basis since 1996, pursuant to the State of Hawaii Department of Health (DOH) guidance document (DOH, 2002) and the facility's final

Groundwater and Leachate Monitoring Plan dated October 7, 1995 and revisited in June 1997 (RUST).

In April 2001, WMH conducted a tidal study in the three monitoring wells (WHW-01 to WHW-03) to evaluate average hydraulic gradient at the site and the need for additional groundwater monitoring wells. One additional groundwater monitoring well was recommended to serve as a point of compliance monitoring well and improve the understanding of groundwater flow direction in the vicinity of the landfill (WMH, February 26, 2002).

A Workplan for installation of an additional monitoring well at the WHSL was prepared in 2002, and WHW-04 was installed between December 2002 and January 2003 along the western property margin. There are a total of four groundwater monitoring wells (WHW-01 through WHW-04) and one groundwater production well at the facility.

This Revised Monitoring Plan ("Plan") presents an updated groundwater monitoring program that incorporates the four onsite monitoring wells WHW-01, WHW-02, WHW-03, and WHW-04. This plan was prepared to comply with Code of Federal Regulations (CFR), Solid Waste Disposal Facility Criteria (and its revisions) in 40 CFR Part 258 (Subtitle D) and State of Hawaii (Title 11, Chapter 58.1, Hawaii Administrative Rules [HAR]). This Plan is intended to supersede the Groundwater and Leachate Monitoring Plan dated October 7, 1995 and revisited in June 1997 (RUST) and reflects the guidance presented in the 2002 State of Hawaii Landfill Groundwater Monitoring Guidance Document (hereinafter "Guidance Document").

## **1.2 Program Overview**

Detection monitoring involves the effective use of monitoring parameters (or "indicator" parameters) and sampling locations to provide early and reliable detection of a potential release from a facility. The objective is to select proper sample locations and parameters, identify an appropriate "background" (i.e., sampling media that has not been affected by the facility and that represents the media at the relevant point(s) of compliance), and evaluate potential changes in water quality using an effective statistical methodology. The statistical methodology must balance the need to be environmentally sensitive, while not creating an unacceptably high false positive error rate.

This Plan describes the hydrogeologic setting of the WHSL, the proposed monitoring network, monitoring frequencies, monitoring parameters, a sampling and analysis plan, and site-specific statistical methodology. Additionally, this Plan incorporates the results of recent site studies designed to provide a better understanding of regional and site specific groundwater, and presents an updated site conceptual groundwater flow model.

This Plan will serve as a reference document for personnel performing site monitoring during the active life of the landfill and during closure and post-closure periods.

This Plan has been organized as follows to incorporate the key aspects of the Guidance Document:

- Chapter 1 -- Introduction and background information
- Chapter 2 -- Characterization of regional and site-specific geologic and hydrogeologic conditions
- Chapter 3 -- Rationale for selection of groundwater and leachate monitoring points, monitoring parameters, and monitoring frequencies
- Chapter 4 -- Data evaluation and statistical methodologies for detection monitoring, including decision standards for identifying significant changes in groundwater quality
- Chapter 5 -- Laboratory analysis plan, including program QA/QC procedures
- Chapter 6 -- Data quality review, reporting, and recordkeeping procedures
- Chapter 7 -- Sampling and analysis procedures

## **2. HYDROGEOLOGIC SETTING**

### **2.1 Climate and Topography**

The climate at the WHSL is arid. The site receives between 10 to 20 inches of precipitation annually. The nearest rain gauge is Station 95.8 near Waikoloa at Elevation 880 feet MSL (NOAA, 1986 through 2006). The site receives between 10 to 20 inches of precipitation annually. The annual rainfall measured at this station averages about 15 inches. January is the wettest month of the year with a median rainfall of about 1.5 inches. The driest month is June with a median rainfall of less than 0.5 inch.



The nearest evaporation observation site is Station 95.60, near Waikoloa at Elevation 405 feet (Ekern and Chang, 1985). This station was operated by the University of Hawaii Water Resources Research Council between 1975 and 1976. It reported an adjusted annual pan evaporation rate of approximately 100 inches and mean monthly pan evaporation rates of roughly 7 to 12 inches. July had the highest mean monthly pan evaporation with a rate of 12.4 inches.

Temperatures typically range between 60 to 95 degrees Fahrenheit. These figures are based on the two nearest temperature observation stations at Puukohola and at Keahole Point (NOAA, 1986 through 1991). Relative humidity averages under 40 percent during the later morning and afternoon hours.

The existing topography of the site is rugged with severe local elevation variations. In general, the site varies between elevations 150 to 235 feet MSL. Average slopes vary from 2 to 5 percent typically in the northwest direction with locally steep slopes. At closure, maximum elevations of the landfill will be approximately 262 feet MSL, which is 30 feet above the current maximum site elevation of 232 feet MSL. This height above the surrounding terrain was established in the Environmental Impact Study (Towill, 1991). Site topography is shown on Figure 2.

## **2.2 Regional Geology**

The island of Hawaii is the youngest of the Hawaiian Islands. Commonly referred to as the Big Island, Hawaii has nearly twice the land area of the remaining islands. Like the other islands, Hawaii was formed by volcanic activity and is still expanding due to current eruptions. Five volcanoes are on Hawaii. Mauna Kea, the highest of the five and inactive, has a peak elevation of 13,796 feet MSL and is east of the site. Kohala (5,480 feet MSL) is inactive and is north of the site. Kilauea (4,093 feet MSL) and Mauna Loa (13,677 feet MSL) are both active volcanoes southeast of the site. Hualalai (8,271 feet MSL) is south and the closest volcano to the site (about 15 miles). Hualalai last erupted in about 1800. Mauna Kea and Kohala have not erupted for several hundred years. All six volcanoes of the "Big Island" share a common evolution through three petrological stages: a basaltic, mainly tholeiitic shield-building stage, a discontinuous period of alkaline volcanism, and a period of quiescence followed by a brief period of post-erosional volcanism.

The WHSL is located within the Mauna Loa volcano boundaries. The rocks of Mauna Loa have been divided into four formations: the Ninole and the Kahuku Basalts, the Pahala Ash, and the Kau Basalt (Stearns and Macdonald, 1964; Macdonald and Abbott, 1970).

Lavas of the Ninole Basalt are only exposed in a series of steep-sided hills along the east side of the southwest rift zone of Mauna Loa. The Kahuku Basalt includes older lavas of Mauna Loa that are exposed along the Kahuku Pali, along the south slope of Mauna Loa, along the Kaoiki Fault scarp, and in a large triangular kipuka between Kilauea and the northeast rift zone of Mauna Loa. Both the Ninole and Kahuku Basalts are overlain by the Pahala Ash, a blanket deposit of fire-fountain debris and reworked ash and stream sediments derived mainly from Kilauea caldera (Fraser, 1960; Easton 1978). The Pahala Ash is covered by more recent lavas on both Mauna Loa and Kilauea. Mauna Loa rocks younger than the Pahala Ash are grouped into the Kau Basalt, which includes the present-day lavas. The thickness section (600 feet) of Kau Basalt is exposed in the summit caldera of Mauna Loa. Mauna Loa has erupted 39 times (flank and summit eruptions) from 1832 to present (Macdonald, Abbott, Peterson, 1970 and 1983).

### **2.3 Regional Hydrogeology**

On a regional scale, fresh groundwater in aquifers on Hawaii is similar to other islands, and occurs as a lens floating above and displacing saline groundwater. Because of this relationship, groundwater wells that are drilled too deep or are over-pumped are susceptible to seawater intrusion. Generally, the fresh water lens is thickest at the center of the island and thins toward the edges of the island at sea level (e.g. Hufen and others, 1980).

Because rainfall tends to be greatest in the island's interior mountainous areas, recharge to the basal groundwater bodies is also greatest in these regions. As a result, groundwater levels are highest inland and groundwater flow is generally from inland areas outward toward the coast.

According to the County of Hawaii Water Master Plan (County of Hawaii, 1980), the site is in Hydrographic Area 5, which covers portions of South Kohala, North Kohala, North Kona, and Hamakua. This area receives the least rainfall of all hydrographic areas in the island of Hawaii. The total sustainable yield from Area 5 groundwater

aquifers was estimated at 40 million gallons per day (mgd) (State of Hawaii, 1979; U.S. Geological Survey, 1975).

The quality of groundwater in the volcanic aquifers is generally good, except where proximity to the ocean results in elevated salinity (Takasaki, 1971). Chloride concentration in the WHSL groundwater production well is approximately 1,000 milligrams per liter (mg/L).

## **2.4 Site Geology**

The site is on the leeward side of Hawaii on the Kona coast. The Pacific Ocean is 1 ¼ miles northwest of the site. The Kona coast is an arid plain of lava flows shielded by the mountains from the rain of the prevailing trade winds. The site is situated on a barren 1859 Mauna Loa lava flow more than 1 ½ miles from any populated areas (Figures 1 and 3). The lava flow consists of basalt with little ash cover. Both types of lava, a'a and pahoehoe, are found at the site. Tumbled heaps of clinker-like and sharp a'a lava cover about 85 percent of the site while localized exposures of very hard basalt rock formation (older pahoehoe lava) covers the rest. Geological investigations indicate fractured basalt exists below the surface a'a lava.

The geology beneath the landfill consists largely of hard, gray vesicular basalt (fractured bluerock). Thin intermittent layers of reddish gray basalt fragments (clinker) lie widely spaced between the dense bluerock layers. Lava tubes, holes, and large cracks are known to exist in the region.

Previous geotechnical field explorations encountered a surface layer, 1.5 to 6.5 feet in thickness, of loose to medium-dense gravel and cobble-sized basalt fragments (clinker). Dense to very dense volcanic basalt were encountered below the clinker layer to the maximum depths explored (around 40 ft bgs) (Geolabs-Hawaii, 1992). The boring logs recorded during installation of the four site wells (WHW-01 through WHW-04) show an alternating sequence of a'a clinker and bluerock basalt. In addition, numerous lava flow contacts and fractures are present to a maximum depth of 247.5 ft bgs (WHW-01).

## **2.5 Site Hydrogeology**

The state Department of Land and Natural Resources (DLNR) estimates the groundwater table elevation at the site to be at 3 feet MSL, roughly 160 to 210 feet

below the existing ground. The estimated hydraulic gradient is 0.0002 foot/foot (ft/ft) (Kanehiro and Peterson, 1977). The regional groundwater flows in a northwesterly direction toward the ocean.

The WHSL is located in the northwest Mauna Loa aquifer sector, within the limits of the Kiholo aquifer system and in close proximity to the boundaries of the Anaehoomalu aquifer system to the north. The shallow groundwater aquifer beneath the WHSL occurs within the underlying sequence of fractured basalt flows and clinker. This basal unconfined aquifer is modified by the Ghyben-Herzberg relationship of a freshwater lens floating on the underlying seawater. The permeability of the rock in this region (North Kona) is relatively high with estimated hydraulic conductivities ranging from 500 to 33,900 foot/day (ft/d) (Bauer, 2003). Slug tests on site at groundwater monitoring WHW-04 which yielded horizontal hydraulic conductivities of greater than 5,000 ft/d. The high permeabilities and lack of caprock (alluvium, clays, and fossilized coral reef with less permeability) at the coast prevent the buildup of a thick freshwater lens and provide a relative flat hydraulic gradient. The groundwater beneath the landfill is brackish with high values of sodium and chloride, and approximately 2,500 parts per million (ppm) of total dissolved solids (TDS).

Site groundwater monitoring wells WHW-01 through WHW-03 and the WHSL production well were installed from September to December 2003. Monitoring well WHW-04 was installed from December 2002 to January 2003. Well construction details are summarized in Table 2-1. Based on historical water level data from site monitoring wells, groundwater is encountered from 150 to 250 ft bgs (0.5 to 2.5 ft above MSL). Since June 1996, the average groundwater flow direction at WHSL has historically been approximately to the west-southwest. Historic groundwater elevations are presented in Table 2-2. In general, the groundwater gradient is relatively flat (less than 0.0005 feet per foot), and calculated groundwater velocities are generally on the order of 2 to 3 ft/dy.

The landfill operates a groundwater production well as a source for wash water and dust control. There are few potable water supplies in the hydrographic area. These are used by residences, ranchers and resort developments primarily for drinking and domestic purposes. There are no drinking water wells downgradient of the proposed landfill site.

There are no County water systems in the general vicinity. The nearest potable water system is a private system owned and maintained by the Waikoloa Resort Company.

The well sources of this water system are approximately 8.4 miles north of the site at Elevation 1,200 feet (19E 57' 15E 45'W, Drinking Water Well Nos. 5745-01 and -02) (DLNR, 1992).

The nearest drinking water well to the site is approximately 3.9 miles away in Puuwaawaa at Elevation 930 feet (19E 49'N, 155E 53'W, Drinking Water Well No. 4953-01) (DLNR, 1992).

Numerous wells used for irrigation and agricultural (nonpotable) purposes are reported in the general vicinity (HLA, 1993). The Waikoloa Resort owns and maintains all of the nearby wells.

The nearest nonpotable water well is approximately 1.5 miles away in Waikoloa at an elevation of 35 feet (19E 55'N, 155E 53'W, Other Water Well No. 5553-01) (DLNR, 1992). The nearest injection well is approximately 1.4 miles away in Waikoloa at an elevation of 35 feet (10E 55'N, 155E 53'W, Injection Well No. 01, HLA, 1993).

#### **2.5.1 Tidal Influence Evaluation and Apparent Groundwater Flow Direction**

Water levels in monitoring wells at the WHSL are tidally influenced. A tidal influence study was conducted at the WHSL on April 6 through April 8, 2001, during a period of moderate tidal events. The purpose of the study was to assess the impact of tidal fluctuations on the groundwater beneath the vicinity of the WHSL and to further evaluate the groundwater flow conditions and the need for an additional monitoring well (WHW-04).

Synchronized groundwater level measurements were recorded with transducers and data loggers in monitoring wells WHW-01, WHW-02, and WHW-03. All three of the monitoring wells showed clear tidal signatures and it was concluded that no significant barrier to groundwater flow exists between the WHSL and the coast. The WHSL is located approximately 6,600 inland from the Pueo and Keawaiki Bays.

Mean groundwater elevations recorded by the transducers and data loggers were computed using the 25-hour moving average method proposed by Serfes (1991). The average water levels were computed using 2 separate 25 hour consecutive hourly water-level measurements recorded during the two day period. Results of the tidal influence study indicated that groundwater elevations at the site fluctuate moderately due to tidal

effects. Figure 4 provides a hydrograph for each monitoring well showing the tidal response during the 2-day monitoring study.

The magnitude of groundwater fluctuations and the delay in response (or lag time) varied across the WHSL. The amplitude of tidal response recorded at the monitoring wells was approximately 0.45 feet in wells WHW-01 and WHW-02, and 0.73 feet in well WHW-03. As expected, the largest amplitude occurred in well WHW-03, located to the northwest in closest proximity to the shoreline at the downgradient portion of the site. The tidal amplitude recorded in the sea at Kawaihae, located 10 miles to the north, during the two-day tidal study is estimated to be around 2.0 feet. Based on this estimation, the tidal efficiency of the aquifer (ratio of tidal amplitude in the wells to that of the sea) is about 20 to 35 percent. The lag of tidal response recorded in the wells compared to tidal fluctuation in the sea at Kawaihae range approximately from 1.5 to 2.5 hours. These results indicate that manual water level measurements recorded at the monitoring wells over a period of 1-2 hours should provide data that can be used to calculate representative hydraulic gradients. Rigorous averaging of tidal influence is not necessary to evaluate groundwater flow direction.

In addition, the results of the evaluation also suggest that tidal influences have a moderate impact on overall groundwater flow direction at the site. The groundwater flow direction has historically been to the west-southwest. The initial twenty-four hour monitoring period recorded in 2002 during the tidal study indicated a westerly shift in flow direction when compared to historic monitoring events. The second twenty-four monitoring period suggested a southerly shift in flow direction. However, an average of the two 24 hour periods was consistent with previous monitoring events.

Based on the results of the tidal evaluation and groundwater monitoring data, it was recommended that an additional well (WHW-04) be installed downgradient along the western property margin in order to accommodate potential groundwater flow fluctuations due to tidal affects. Monitoring well WHW-04 was installed between December 2002 and January 2003.

### **2.5.2 Hydrogeochemistry**

The inorganic geochemistry of groundwater beneath the WHSL is strongly influenced by the coastal location of the facility. Groundwater in onsite monitoring wells is sodium-chloride type water with slightly alkaline pH, and relatively high total dissolved

solids (TDS). Concentrations of dissolved solids in the groundwater generally decrease from west to east reflecting the facility's location within a transitional zone of sea water-fresh water mixing.

### **2.5.3 Surface Water Hydrology**

Due to the arid nature of the site, little runoff is expected that needs to be managed in a surface water management system. The site receives between 10 to 20 inches of precipitation annually. The adjusted pan evaporation at the site is estimated at 100 inches per year (Ekern and Chang, 1985). The 25-year, 24-hour design storm is 5.0 inches (Department of Commerce, 1962). There are no natural drainage courses evident in the facility area indicating that runoff is minimal. This is expected due to the rough and porous nature of the a'a lava and the drainage capacity of the fractured basalt beneath the site.

The WHSL has been designed with a perimeter infiltration ditch to collect runoff from the landfill and any infiltration drainage from the granular layers in the final cover. Due to the porous nature of the soils used to construct the cover and ditch, runoff is expected to infiltrate into the subsurface. If significant runoff is detected in the perimeter ditch or begins to cause erosion in the ditches or on the steeper landfill faces, additional surface water management features will be added. The perimeter infiltration ditch can be directed to a retention pond that can either discharge across the lava field for percolation or the pond can be operated as an evaporation pond.

## **3. GROUNDWATER MONITORING**

### **3.1 Groundwater Monitoring Network**

Detection monitoring wells installed for the WHSL were located using previous flow direction information to better target the primary points of leachate accumulation (leachate sumps). An appropriate groundwater detection monitoring network can be designed based on flow direction and velocity information.

The current groundwater monitoring network includes two monitoring wells located along the eastern property margin (WHW-01 and WHW-02) and two monitoring wells located along the western property margin (WHW-03 and WHW-04). Locations of the four monitoring wells are shown on Figure 2. Wells WHW-01 and WHW-02 are

located hydraulically upgradient of site operations and are ideally located to monitor background water quality in the vicinity of the WHSL.

As discussed in Section 2.5.1, water levels in monitoring wells at the WHSL are tidally influenced. The results of the tidal study conducted in April 2002 and historic groundwater elevation data for monitoring wells WHW-01, WHW-02, and WHW-03 show apparent groundwater flow directions ranging from west to southwest in the immediate vicinity of the WHSL. Based on the tidal study data and the historic groundwater flow directions, monitoring well WHW-04 was installed downgradient to the west-southwest of the leachate sumps (R1, R2, and R3).

Since June 1996, the groundwater flow direction at WHSL has historically ranged from southwest to west with an average flow direction approximately to the west-southwest. Figure 5 shows the 19 June 2007 groundwater elevation contours at the site. The groundwater gradient calculated in the central portion of the landfill is about 0.00009 foot/foot (approximately 0.47 feet/mile) to the southwest. Groundwater velocity is calculated using the equation  $V = Ki/n$ , where  $K$  = hydraulic conductivity,  $i$  = hydraulic gradient, and  $n$  = effective porosity. Using an estimated  $K$  value of 5,000 ft/day (Bauer, 2003) for the North Kona area, a gradient of 0.00009, and an effective porosity of 0.20 for recent a'a lava flows, the groundwater velocity is calculated to be approximately 2.25 ft/day.

Based on the westerly to southwesterly groundwater flow direction and calculated groundwater velocity, monitoring wells WHW-03 and WHW-04 are downgradient of the leachate sumps (see Figure 5) and meet the need for monitoring potential impacts to groundwater.

Results of the long-term monitoring of the WHSL monitoring wells will be used to continue assessment of fluctuations in groundwater flow direction and gradient to further evaluate if the current monitoring network is sufficient for long-term detection monitoring.

### **3.2 Groundwater Monitoring Parameters**

HAR Chapter 11-58.1 (1) requires that MSW landfills routinely monitor groundwater for the 15 metals and 47 volatile organic compounds (VOC) listed in Appendix I of Chapter 11-58.1. This is the same list of monitoring parameters contained in the Federal



Subtitle D regulations (40 CFR Part 258, Appendix I) and, in addition to containing an excessively large number of parameters, also contains several parameters (i.e., the 15 metals) which are generally viewed as ineffective monitoring parameters because of their limited mobility in most subsurface environments. The United States Environmental Protection Agency (USEPA) intended the Appendix I analytes to be default parameters for use in those states which have not yet obtained Subtitle D authorization. Through 40 CFR Part 258.54 (a)(1) and (2) the USEPA has provided authorized states, such as Hawaii, the flexibility to approve alternative lists of site-specific monitoring parameters. This flexibility, specifically outlined in HAR Chapter 11-58.1 subsections (1)(A) and (B), has been reflected in the development of previous groundwater monitoring programs for the WHSL (e.g., RUST, 1997).

Accordingly, this Plan describes the approach for selecting an updated alternative list of site-specific groundwater monitoring parameters for use during detection monitoring at the WHSL, and incorporates the approximate 10 years of additional monitoring data collected since the preparation of the previous WHSL groundwater monitoring program (RUST, 1997).

### **3.2.1 Site-Specific Detection Monitoring Selection Strategy**

It is widely accepted that a combination of volatile organic compounds (VOCs) plus a carefully selected “short list” of site-specific water quality parameters (referred to herein as “detection monitoring parameters”) will typically provide the most reliable monitoring parameters for most MSW landfills. VOCs in particular can be highly effective detection monitoring parameters for providing an early indication of a potential release from a landfill because they are: (1) rarely detected in background groundwater samples; (2) detected more frequently than any other class of organic compounds in solid waste landfill leachate (Cravy et al., 1990; Plumb, 1991); and (3) are analytically sensitive (i.e., they can be detected at extremely low concentrations); and (4) are relatively mobile in the groundwater system. Although commonly present in MSW landfill leachate, semi-volatile organic compounds (SVOCs), as a group, are significantly less mobile than VOCs in most subsurface environments and do not typically provide for substantial additional monitoring benefits.

The above strategy (i.e., VOCs in conjunction with a short list of statistically evaluated detection monitoring parameters) has been implemented as a part of previous WHSL groundwater monitoring programs (e.g., RUST, 1997) and is consistent with the

monitoring parameter selection strategy outlined in the Guidance Document. This Plan reaffirms this strategy but provides a re-evaluation of detection monitoring parameters using updated groundwater and leachate monitoring data.

The VOCs listed in Appendix I of Subtitle D, which have been monitored in accordance with the previous WHSL monitoring program (RUST, 1997) will continue to be routinely monitored as part of the detection monitoring outlined in this Plan. It is also important to note that the “short list” of site-specific detection monitoring parameters pertains only to parameters that will be subjected to routine statistical analysis for compliance monitoring purposes; appropriate additional “supplemental geochemical parameters”, not subject to routine statistical evaluation, are also identified and included in the groundwater monitoring program. The supplemental geochemical parameters will provide additional data for evaluating site groundwater conditions.

### **3.2.2 Site-Specific Statistically Evaluated Detection Monitoring Parameters**

Water quality monitoring parameters are those parameters that occur naturally in groundwater and for which a background concentration must be established in order to effectively evaluate a possible leachate release. For detection monitoring purposes, the use of the minimum number of effective water quality monitoring parameters is the preferred approach over utilization of a very long list of monitoring parameters, such as the list of metals in Appendix I or a generic list of cations, anions, and other common parameters such as TDS. This is true because of the direct relationship between the number of statistical comparisons performed during each sampling event and the resulting false positive error rates. For example, if a given detection monitoring program consists of 5 wells, each of which is sampled for 20 parameters (i.e., 100 statistical decisions per monitoring event), then even using a very low error rate (e.g., 0.01, or 1%) would yield one false-positive result every sampling event. The larger the number of statistical decisions that are performed each sampling event, the higher (i.e., less conservative) the associated statistical limit must be in order to avoid excessively high false-positive results.

As recommended in the DOH Guidance Document, the selection of a list of alternative monitoring parameters for the WHSL is based on actual site conditions and involves a detailed evaluation of available site-specific groundwater and leachate data which, at the WHSL, now contains extensive long-term data (more than ten years). Using the strategies outlined in the Guidance Document, the first step is to identify those water

quality parameters whose concentration in leachate are significantly higher than in groundwater, in order to account for dilution and attenuation processes. The resulting list of potential detection monitoring parameters is then refined further by identifying and removing parameters that provide substantially redundant coverage (e.g., monitoring for both electrical conductivity and TDS; or, for both total organic carbon [TOC] and chemical oxygen demand [COD]). From the remaining parameters, those anticipated to provide the earliest and most reliable indication of a release are selected as detection monitoring parameters for statistical evaluation purposes. This determination is based on the relative mobility of the constituents, the detectability of each parameter using existing analytical methods, the likelihood of false positive results associated with each parameter, as well as any changes in the parameter that might be expected during its migration through the unsaturated and saturated zones beneath the facility (e.g., due to changes in pH or redox conditions).

The Guidance Document suggests that potential detection monitoring parameters first be screened by calculating the concentration contrast between leachate and groundwater. As noted in the Guidance Document, a potentially effective monitoring parameter would exhibit a concentration in leachate at least 5 times greater than the upper background limit in groundwater. Note that a leachate-groundwater contrast of 5X is considered highly conservative based on USEPA guidance, which identifies typical useful leachate-groundwater contrast for potentially useful indicator parameters of at least 10X to 20X (EPA, 1996). If insufficient contrast exists for a specific parameter (i.e., leachate concentration is consistently at or below the background groundwater limit), then that parameter is eliminated from further consideration for detection monitoring. For purposes of this plan, parameters that exhibit insufficient contrast are eliminated from statistical analysis only; many of these parameters are still recommended for monitoring as supplemental geochemical parameters as described in Section 3.2.3.

Table 3-1 summarizes the leachate-groundwater concentration contrasts values for various inorganic and water quality parameters for the WHSL. These values were calculated by dividing the background concentrations calculated using statistical prediction limits for pooled data from groundwater monitoring wells WHW-01 and WHW-02 into maximum leachate values in the WHSL database (through the first half of 2007). The groundwater data were pooled in order to provide sufficient data for statistical calculations and it is assumed that the data are representative of background conditions (i.e., no leachate impact). This is a reasonable assumption given the

upgradient locations of the wells and that no inorganic leachate impact has been indicated in these monitoring wells, as described in the routine monitoring reports. Furthermore, numerous monitoring parameters are potentially viable detection monitoring candidates due to the large contrast between concentrations of chemicals in leachate and groundwater at the WHSL. Contrast values shown on Table 3-1 range over several orders of magnitude and can be categorized as follows based on leachate/groundwater ratio:

Leachate/Groundwater <10:

- Arsenic
- Barium
- Bromide
- Calcium
- Chloride
- Copper
- Lead
- Magnesium
- Nickel
- Selenium
- Sodium
- Solids, total dissolved
- Sulfate
- Thallium
- Vanadium

Leachate/Groundwater = 10 to 100:

- Alkalinity, total (as  $\text{CaCO}_3$ )
- Alkalinity, bicarbonate (as  $\text{CaCO}_3$ )
- Chemical oxygen demand
- Chromium
- Potassium
- Sulfide
- Total Organic Carbon

Leachate/Groundwater >100

- Iron
- Manganese
- Nitrogen, ammonia
- Nitrogen, total Kjeldahl
- Zinc

Because leachate-to-groundwater concentration contrast is just one variable in the selection process for site-specific detection monitoring parameters, the latter group (with contrast values >100) does not necessarily represent the best detection monitoring parameter choices. In fact, all of the parameters in the latter category are subject to potentially significant mobility limitations that would likely render them ineffective for early identification of a leachate release from the facility. With regard to the trace metals in the latter category (iron, manganese, and zinc), several processes interact to influence and limit their transport in the subsurface. These processes include complexation reactions, oxidation/reduction reactions, and physical processes that result in the removal of metal ions from liquid such as adsorption and precipitation. It is well understood that, due to the positive charge of metal ion species, adsorption of metals onto negatively charged clay mineral or organic matter is an important limiting process with respect to metals mobility in this environment. A cation with greater valence state is adsorbed more strongly than a cation with a lower valence state and, for a given valence state, the cation with the smallest radius is adsorbed more strongly than a cation with a large radius. Trace metals, therefore, can be expected to be adsorbed more strongly than the major metals, such as sodium, potassium, calcium, and magnesium, all of which possess relatively large atomic radii and relatively low valence states. Based on these factors, the trace metals in all of the above contrast categories are unlikely to provide effective indication of a potential release from the waste management unit.

Similarly, nitrogen in the form of ammonia and TKN (which is a measure of the reduced form of inorganic nitrogen, i.e., ammonia, and organic nitrogen), is strongly adsorbed due to its positive charge, and its mobility is also greatly affected by redox conditions. Ammonia (and TKN) is most mobile under relatively strongly reducing and/or acidic conditions. Groundwater conditions at WHSL are such that rapid

oxidation and rapid neutral pH buffering can be expected. Therefore, in spite of its relatively large leachate-groundwater contrast, ammonia-nitrogen (and TKN) would be expected to be a less effective detection monitoring parameter than some of the more mobile constituents with lesser leachate-groundwater contrast ratios.

Based on the above considerations, the following constituents in the second contract category (10 – 100) were evaluated further for their potential effectiveness as statistically evaluated detected monitoring parameters: TOC, COD, bicarbonate alkalinity, total alkalinity, sulfide, chromium, and potassium. Of these, the more geochemically mobile constituents were identified and selected for use as statistically evaluated detected monitoring parameters; specifically, total organic carbon (TOC), bicarbonate alkalinity, and potassium. Chemical oxygen demand (COD) was not selected because it essentially provides the same information as TOC: both COD and TOC are gross-scale measures of the organic carbon content of water and a strong positive statistical correlation between TOC and COD is evident in site leachate. Similarly, total alkalinity was not selected because, at the pH conditions of WHSL groundwater, bicarbonate alkalinity prevails, meaning that total alkalinity is providing the same information (i.e., total alkalinity is bicarbonate alkalinity). Sulfide was not selected because it is highly redox sensitive and would not be expected to persist for any significant distance upon a release from the landfill. Chromium was not selected due to the issues related to trace metals described above.

Note that the proposed list of updated statistically evaluated detection monitoring parameters (TOC, bicarbonate alkalinity, and potassium) is intended to replace the current list of statistically evaluated detection monitoring parameters (ammonia-nitrogen, bicarbonate alkalinity, and total dissolved solids [TDS]).

### **3.2.3 Supplemental Geochemical Parameters**

In addition to the use of VOCs, TOC, bicarbonate alkalinity, and potassium as statistically evaluated detection monitoring parameters, the WHSL also incorporates analysis of supplemental geochemical parameters into the routine monitoring program. These supplemental geochemical parameters augment the site-specific detection monitoring parameters such that the general chemical nature of groundwater can be further characterized and potential mechanisms affecting water quality (both natural and man-made) can be better understood and evaluated. The supplemental parameters will not be evaluated statistically. However, they can, on an as-needed basis, provide

critical data for evaluating data reliability and potential changes in groundwater quality without affecting the site-wide false-positive statistical error rate. The following supplemental geochemical parameters are to be analyzed in conjunction with routine detection monitoring parameters during each monitoring event:

- Bromide
- Chloride
- Sulfate
- Dissolved Calcium, Magnesium, Sodium
- Total Dissolved Solids (TDS)

#### **3.2.4 Summary of Site-specific Detection Monitoring and Supplemental Parameters**

The updated detection monitoring parameters for use in detection monitoring at the WHSL are summarized in Table 3-2. Concentration limits using both statistical and non-statistical methods, as appropriate, will be established for each of the detection monitoring parameters (as described in Section 4.0). In addition to routine analysis of the detection monitoring parameters, the supplemental geochemical parameters listed on Table 3-2 will also be analyzed during each routine monitoring event. These supplemental monitoring parameters are collected for geochemical informational purposes and are not subject to statistical analysis or other compliance-related evaluation. The detection monitoring program shall also include the collection of field measurements (i.e., electrical conductance, pH, temperature, turbidity, and groundwater surface elevation) from monitoring wells during each sampling event. Field parameters will be recorded on groundwater monitoring forms during well sampling. As additional leachate data are generated throughout the course of landfill operations, the detection monitoring parameter list will be re-evaluated and updated as required. If parameters are added to the routine detection-monitoring list, background concentrations will be determined using appropriate statistical methods and added to the long-term monitoring program after the changes are approved by the DOH.

### **3.3 Background Sampling**

Newly installed wells will be characterized during their initial sampling event. Characterization will include monitoring of (1) routine detection monitoring

parameters, (2) supplemental geochemical parameters, and (3) Subtitle D Appendix I parameters.

### **3.4 Groundwater Monitoring Schedule**

Groundwater monitoring will be performed semi-annually for existing detection monitoring wells WHW-01 through WHW-04, and quarterly for a period of eight quarters for any newly installed detection monitoring wells (in order to obtain background data to facilitate statistical evaluation).

## **4. LEACHATE MONITORING**

Leachate monitoring has been performed on a routine basis at the WHSL in accordance with the WHSL solid waste operating permit and with previous site monitoring programs (e.g., RUST 1997). Currently, monitoring at SUMP-1, SUMP-2, and SUMP-3 is conducted pursuant to the Monitoring Plan, the *Groundwater, Surface Water, and Leachate Sampling Guide* (WMI 2004) hereinafter referred to as the "Guide"

Monitoring is conducted annually and reported along with groundwater monitoring in routine semi-annual monitoring reports. (e.g., Earth Tech, 2007). A new leachate sump (R-3) was constructed in July 2007. R-3 is a few hundred feet west of R-1 along the northwestern margin of the WHSL.

### **4.1 Leachate Monitoring System**

Leachate samples will be routinely collected to augment the database of potential source information and to evaluate the suitability of site monitoring parameters. Sampling of the following leachate monitoring locations (see Figure 2) is proposed on an annual basis:

- SUMP-1
- SUMP-2
- SUMP-3
- Any other approved leachate collection sumps installed at the site



#### 4.2 Leachate Monitoring Parameters

Routine leachate monitoring parameters will consist of the same parameters used for groundwater detection monitoring and the supplemental geochemical parameters including:

- Alkalinity (includes total, bicarbonate, and carbonate)
- Bromide
- Chloride
- Sulfate
- Calcium, total
- Magnesium, total
- Potassium, total
- Sodium, total
- Total Dissolved Solids (TDS)
- Total Organic Carbon (TOC)
- VOCs (EPA Method 8260B analytes)

Note that leachate samples are not filtered and, therefore, the major cations are shown as “total” for leachate (as opposed to “dissolved” for groundwater).

In addition to the above routine parameters, leachate samples collected from new leachate locations, and leachate samples collected from existing locations every two years (biennial characterization) will be analyzed for the following Subtitle D Appendix I parameters and “leachate indicators”, per the Guidance Document:

- 17 trace metals (Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Tl, Sn, V, Zn) plus cyanide and sulfide
- Semivolatile Organic Compounds
- Pesticides
- Herbicides
- PCBs
- Major cations and anions (covered by routine monitoring, above) – (Mg, Na, Ca, K, Cl, CO<sub>3</sub>, SO<sub>4</sub>, HCO<sub>3</sub>)
- Major leachate indicators (partially covered by routine monitoring, above) – (TDS, TOC, Total Alkalinity, Nitrogen–Ammonia, Cl, Fe)

- Field measurements (performed in accordance with Sampling and Analysis procedures in Section 5.0) – (electrical conductivity, pH, temperature, and turbidity)

## **5. DATA EVALUATION METHODS**

The following subsections describe the criteria by which groundwater data will be evaluated at the WHSL for detection monitoring purposes. These criteria represent a conservative approach to groundwater analysis and incorporate state-of-the-practice statistical and other evaluation methodologies consistent with the Guidance Document.

### **5.1 Statistical Methodology for Evaluation of Inorganic Parameters**

Consistent with the existing groundwater monitoring program at the WHSL, an intra-well monitoring strategy using Shewhart-CUSUM control charts will be used for routine detection monitoring. Shewhart-CUSUM control charts (Gibbons, 1992; Gibbons, 1994) are particularly effective in this capacity because they are capable of detecting both sudden and gradual changes in groundwater chemistry. Combined Shewhart-CUSUM control charts will be constructed for each well where intra-well monitoring is performed to provide a statistical and visual tool for detecting trends and abrupt changes in inorganic groundwater chemistry. The combined Shewhart-CUSUM procedure assumes that the data are independent and normally distributed. The most important assumption is independence (Gibbons, 1994). Therefore, care should be taken to never sample wells more frequently than sample independence can be demonstrated based on site-specific hydrogeological factors. The assumption of normality is somewhat less of a concern because the data can usually be adequately transformed for most applications. Non-detects (NDs) can be replaced by one-half of the PQL without serious consequence, although this procedure should be applied only to constituents that are detected in at least 25% of all samples. For data sets with less than 25% detected values in the background data set, non-parametric prediction limits will be used in lieu of Shewhart-CUSUM control charts.

Intra-well monitoring is always the preferred approach for wells not already impacted by inorganic waste constituents because it eliminates the spatial component of chemistry variability from the statistical evaluation. No impact from inorganic waste constituents has been identified to date in WHSL groundwater.

For intrawell comparisons, a minimum of eight background samples (i.e., from each well in the monitoring program) is required for parametric (i.e., Shewhart-CUSUM) tests and 13 background samples for nonparametric (i.e., Prediction Limit) tests. Additional discussion of intrawell monitoring can be found in Gibbons (1987a, 1987b, 1990, and 1994). Statistical evaluation of groundwater monitoring data will be performed using DUMPStat<sup>™</sup> statistical modeling software, developed consistent with USEPA and ASTM guidance on groundwater monitoring at Subtitle D and Subtitle C facilities (Gibbons and Discerning Systems, 1994; [www.discerningsystems.com](http://www.discerningsystems.com)).

## **5.2 Non-Statistical Methodology for Evaluation of VOCs**

VOCs have been demonstrated to be effective indicators of a release from MSW landfills. However, because these compounds are rarely naturally detected in background groundwater samples, establishing monitor well-specific limits for VOCs is generally not an option. Therefore, a detection monitoring decision rule based on laboratory-specific practical quantitation limits (PQL) will be used to identify a statistically significant monitoring result with respect to VOCs.

It is generally accepted that when a landfill facility actually produces a leachate release to groundwater, multiple constituents contained in the leachate are associated with the source fluids and are subsequently detected by the groundwater monitoring program. A single constituent at very low concentration (i.e. below the PQL) typically is not the signature that is produced from an actual release. The calculation of laboratory-specific PQLs (Gibbons, 1992) already incorporates a measure of the statistical uncertainty that is associated with the measurement process. Therefore, any VOC detected and verified at a concentration above the PQL would be statistically significant, and would therefore trigger assessment monitoring (or an alternative source demonstration if the detection is unrelated to a release from the landfill). This decision rule only applies in cases where the constituent has rarely, or never, been detected in background samples.

PQLs assure that the quantitative value of the analyte is close to the measured value. Method detection limits (MDLs), on the other hand, indicate that the analyte is present in the sample with a specified degree of confidence (Gibbons, 1991). For analytes with estimated concentrations greater than the MDL but not the PQL, it can only be concluded that the true concentration is greater than zero; the actual concentration cannot be determined. The actual concentration of an analysis result between the PQL

and the MDL (often referred to as a “trace” result or a “J-flagged” result) may actually be less than the MDL. Therefore, comparison of a detected concentration to a maximum contaminant level (MCL), or any other concentration limit, is not meaningful unless the concentration is greater than the PQL.

Although the use of VOC results reported between the MDL and PQL is not appropriate for use in the decision rule, such trace/J-flagged results can be used to guide further investigation in the event that long-term, repeatable trace/J-flagged results are observed.

### **5.3 Detection Verification Procedure**

If groundwater analysis results have been collected, checked for quality assurance and quality control (QA/QC) consistency and are determined to be above the appropriate statistical level (i.e., the Shewhart-CUSUM control chart limit or non-parametric prediction limit for inorganic monitoring parameters, or the PQL for one or more VOCs), the results should be verified in accordance with the objectives of 40 CFR Part 258.53 and HAR Chapter 11-58.1.

Verification resampling is an integral part of the statistical methodology described by the USEPA's *Addendum to Interim Final Guidance Document – Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (July 1992). Without verification resampling, much larger statistical limits would be required to achieve site-wide false positive rates of 5% or less. Furthermore, the resulting false negative rate would be greatly increased. For the WHSL groundwater detection monitoring program, the following procedure will be performed for each compound determined to initially be above its statistical limit. Note that only those compounds that initially exceed their statistical limit should be sampled for verification purposes; otherwise, an unacceptably high false-positive error rate can be expected (e.g., if PCE is the only compound detected during an EPA Method 8260B scan, then only PCE is targeted and reported by the laboratory during the retest).

#### **Volatile Organic Compounds**

If one or more VOCs is/are detected above statistical limit(s) (i.e., PQL), one immediate resample and analysis should be conducted. A statistical exceedance will be recorded and assessment monitoring initiated if any single VOC is measured above the PQL in

the verification resample, or an alternative source demonstration may be performed if the exceedance is not anticipated to be associated with a release from the facility.

#### Inorganic Constituents

If one or more of the inorganic parameters are detected above their statistical limit (i.e., Shewhart–CUSUM control chart limit or non-parametric Prediction Limit), one verification resample will be collected at the next scheduled sampling event. A statistical exceedance will be recorded and assessment monitoring initiated if verification of an elevated parameter is confirmed for one discrete verification resample. The facility may propose to implement an alternative source demonstration if it is believed that the exceedance is not a result of a release from the facility. In either case, the appropriate regulatory actions will be implemented.

#### **5.4 Qualifier and Outlier Groundwater Data Evaluation**

Prior to the statistical evaluation of inorganic monitoring parameters, it will be necessary to examine the historical background data set on which statistical limits are calculated for outliers, anomalies, and trends that might confound the evaluation procedure. Outliers and anomalies are inconsistently large or small values that can occur due to sampling, laboratory, transportation or transcription errors, or even by chance alone. Significant trends indicate a source of systematic error, or an actual contamination occurrence that must be evaluated before the detection monitoring program can be implemented to its full effectiveness. The inclusion of such values in the historical background data set could result in an artificial increase in the magnitude of statistical limits, which could result in an increase in the false negative rate (i.e., a decrease in the sensitivity of the statistical procedure).

To remove the possibility of this type of systematic error, outliers are removed from consideration during the establishment of background. The outlier detection procedure will be performed for those wells that have at least 4 measurements for a given constituent using time vs. concentration graphs. Parameter concentrations that appear anomalous (i.e., that are 5 times or greater than the previous results) should be verified during the next sample collection event or after a reasonable period of time to ensure sample independence (e.g., six months). If the potential outlier result is not verified, the anomalous sample result should be removed from the database. Any detected

systematic trends in the background database should be evaluated and reported within 90 days.

Detection monitoring parameters should be evaluated based on time vs. concentration graphs for each constituent for each well. Should a significant trend of a constituent, an unexpected geochemical signature at a well as indicated on a piper or stiff diagram, or an anomalously high result (i.e., greater than 5 times average background concentration) be verified after results have been checked for QA/QC, DOH will be notified within 90 days.

Potential outlier data should have an associated Data Quality Report (DQR) prepared by the laboratory to determine the quality and integrity of the data in question. Information provided in the DQR will be important in evaluating the significance of the analysis result(s) and determining whether a result represents an outlier, a cross-contaminated value, or other laboratory error.

In addition, the characterization of leachate should be performed as soon as leachate can be sampled to potentially amend the list of detection monitoring parameters. Source characterization is an effective technique in reducing false positive and false negative detections because groundwater concentrations of a parameter must be correlated with source concentrations (i.e., source concentrations must be greater and in appropriate contrast with groundwater concentrations). Therefore, if a parameter is detected in groundwater at a concentration of concern but that parameter is either not in leachate, or in leachate at a much lower concentration, it can be concluded that the source of the parameter is not leachate. If after this evaluation leachate is still suspected as the source of the parameter, verification resampling should be conducted.

To remove the possibility of historical outliers and trends creating false statistical limits, the historical data for each well and each constituent should be tested for the existence of outliers (Gibbons, 1994). Outliers will be removed from consideration during the establishment of all statistical limits. Once the background database is established, the outlier procedure described above should be applied and appropriate statistical limits set in accordance with Section 5.1 Statistical Methodology, above.

## **5.5 Assessment Monitoring**

Assessment monitoring will be conducted in accordance with HAR Chapter 11-58.1 if, during detection monitoring, a statistically significant increase over background has been detected and verified for one or more of the detection monitoring parameters identified in Section 3.0.

## **6. SAMPLING PROCEDURES**

Sampling and analysis procedures for groundwater, leachate, and surface water monitoring at the WHSL shall be performed in accordance with the Guide, March 5, 2004 Version 1.0", prepared by the Waste Management, Inc. (WMI) Groundwater Protection Program (The Guide represents the general requirements for groundwater, surface water, and leachate sample collection at sites owned and/or operated with environmental responsibility by WMI, and is generally consistent with the practices detailed in the Hawaii Guidance Document. The Guide is derived, in part, from the guidelines set forth in the following ASTM Environmental Standards:

- ASTM Standard D1129-90, (1990) - Terminology Related to Water
- ASTM Standard D3370-82, (1989) - Standard Practices for Sampling Water
- ASTM Standard D4840-88, (1993) - Practice for Sampling Chain of Custody Procedures
- ASTM Standard D3694-93, (1993) - Practices for Preparation of Sample Containers and for Preservation of Organic Constituents
- ASTM Standard D5088-90, (1993) - Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites

The Guide should be reviewed and signed by all sampling team members prior to initiation of routine or special groundwater sampling events at the WHSL. All well construction information and documentation of completed sampling events will be filed and available on site. All sampling team members must sign a Signature Page, verifying that they have read and understand this Guide and note any exceptions to the Guide.

Site conditions at the WHSL or site-specific regulatory requirements may necessitate a deviation from the Guide as described herein. Any such deviation from this Guide must

be documented by the sampling team leader in coordination with the WMH Environmental Protection Manager or WM West Group Hydrogeologist.

## **7. LABORATORY ANALYSIS PLAN**

This section describes the procedures for completing successful laboratory analyses of the samples that are collected at the WHSL. The procedures are drawn extensively from the Guidance Document.

### **7.1 PROGRAM QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES**

Trip blanks, equipment blanks, and field blanks will provide QA/QC measures for the monitoring program, as explained below.

#### **7.1.1 Trip Blanks**

Trip blanks are a required part of the field sampling QA/QC program. They are used to detect contamination that may be introduced in the field (either atmospheric or from sampling equipment), in transit (to or from the sampling site), or in the bottle preparation, sample log-in, or sample storage stages at the laboratory. Laboratory method blanks are used during the analytical process to detect any laboratory introduced contamination that may occur during analysis.

Trip blanks are samples of organic-free water (e.g., deionized) prepared at the laboratory. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Trip blank sample bottles must not be opened at any time during this process. Upon return to the laboratory, trip blanks will be analyzed for VOCs using the same procedures and methods that are used for the collected field samples. For the WHSL, one trip blank will be placed in each cooler containing VOCs.

Trip blank results should be reported in the laboratory results as separate samples, using the designations TB-(well#) as their sample point designation.



### 7.1.2 Field Blanks

Field blanks are a highly recommended part of the field sampling QA/QC program. The purpose of the field blank is to detect any contamination, which might be introduced into the groundwater samples through the air. For sites with sampling programs involving VOCs, at least one field blank should be analyzed for the first 20 samples or less. At least one field blank sample should be collected for each day of sampling, and for each subsequent 20 samples, whichever is greater. For the WHSL, sampling is typically completed in one day, and comprises less than 20 samples, so a single field blank will be collected during each monitoring event.

For programs that do not involve volatile organics analyses, a duplicate well sample should take the place of the field blank.

Field blanks must be prepared in the field (at the sampling site) using laboratory-supplied bottles and deionized or laboratory reagent-quality water. Each field blank is prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. The well at which the field blank is prepared must be identified on a Field Information Form, along with any observations that may help explain anomalous results (e.g., prevailing wind direction, up-wind potential sources of contamination, etc.). Once a field blank is collected, it is handled and shipped in the same manner as the rest of the samples.

For dedicated or disposable equipment requiring no filtration, or in-line filtration, the deionized or laboratory reagent-quality water is exposed to the air, transferred to the field blank bottles, and the proper preservative added as required. If the required filtration is not done in-line, the deionized or laboratory reagent-quality water is exposed to the air, poured into pre-filtration bottles, filtered (as required), placed in the field blank bottles, and the proper preservative is added as required.

Field blank results should be reported in the laboratory results as separate samples, using the designations FB-(well #) as their sample point designation.

### 7.1.3 Equipment Blanks

At the WHSL, all sampling equipment is dedicated, and in general equipment blanks are not required or collected. For non-dedicated equipment, if used, decontamination

procedures consist of rinsing the equipment once with deionized or laboratory reagent-quality water, brushing the equipment with a laboratory-quality soap, and triple rinsing the equipment with deionized or laboratory reagent quality water.

Deionized or laboratory reagent-quality water is poured into the sampling device (e.g., the bailer) prior to sampling. If the analytes for the equipment blank would normally be filtered, this water should be placed into a pre-filtration bottle and subsequently filtered. Whether or not it is filtered, this water is placed into the field blank bottles, and the proper preservative added as required.

Equipment blank results should be reported in the laboratory results as separate samples, using the designations EB-(well#) as their sample point designation.

## **7.2 Laboratory Quality Control Procedures**

The quality assurance program for the laboratory is described in their Quality Assurance Program Plan (QAPP), which is available from the laboratory upon request. The QAPP describes mechanisms the laboratory employs to ensure that all data reported meets or exceeds all applicable EPA and State requirements. It describes the laboratory's experience, its organizational structure, and procedures in place to ensure quality of the analytical data. The QAPP outlines the sampling, analysis, and reporting procedures used by the laboratory. The laboratory is responsible for the implementation of and adherence to the quality assurance and quality control requirements outlined in the QAPP.

Audits are an important component of the quality assurance program at the laboratory. Audits are conducted by the laboratory. Internal system and performance audits should be conducted periodically to ensure adherence by all laboratory departments to the QAPP.

Data Quality Reviews (DQR), or equivalent, are requests submitted to the laboratory to formally review results that differ from historical results, or that exceed certain permit requirements or quality control criteria. The laboratory should prepare a formal written response to each DQR explaining the discrepancy. The DQR is the first line of investigation following any anomalous result.

### 7.3 Practical Quantitation Limits (PQLs)

Laboratory-specific PQLs should be used as the reporting limits of applicable low-detection-frequency analytes (especially organics). The EPA developed the concept of the PQL to address the issue of analytical variability. The PQL concept was developed for compliance with the Safe Drinking Water Act (50FR46906, Nov. 13, 1985) where it is defined: "The PQL thus represents the lowest level achievable by good laboratories within specified limits during routine laboratory operating conditions." The EPA states in 52FR25699 (July 8, 1987): The Agency developed the PQL concept to define a measurement concentration that is time and laboratory independent for regulatory purposes. Method Detection Limits, although useful to individual laboratories, [do] not provide a uniform measurement concentration that can be used to set standards.

The EPA's defined MDL, as published in 40 CFR136, has limited application. The Agency acknowledges that "MDLs are not necessarily reproducible over time in a given laboratory, even when the same analytical procedures, instrumentation and sample matrix are used" (50FR46906, Nov. 13, 1985). As indicated in 52FR 25699 please check reference (July 8, 1987), the MDLs have had a tendency to be misunderstood by regulatory agencies developing policies for how low-concentration standards (in this case, "detection of a contaminant") can be established. The use of MDL's may result in false positives since the EPA admits it is an ideal limit that cannot be reliably measured by even the best laboratories. Therefore, in its regulatory programs, the EPA has determined that the PQL is a more appropriate measure for compliance purposes.

While the EPA has defined PQLs, these limits are often based on consensus rather than operational definitions and experimental evidence. The actual PQL limit that may be achieved in a specific laboratory for a specific compound may be higher or lower than the PQLs listed in SW-846. In contrast to the PQL, which is a measure of analytical precision, the MDL is a hypothesis test that leads to the binary decision of whether or not an analyte is present or absent in a sample. The MDL is defined by the EPA as the "minimum concentration of a substance that can be measured and reported with 99 percent confidence that the true value is greater than zero" (50FR46906, Nov. 13, 1985).

#### **7.4 Analytical Methodologies**

Table 7-1 summarizes the analytical methodologies to be used by the laboratory for the routine analysis of groundwater and leachate.

Table 7-2 summarizes the analytical methodologies to be used by the laboratory for the initial characterization of newly installed groundwater monitoring wells.

Table 7-3 summarizes the analytical methodologies to be used by the laboratory for the initial characterization of new leachate sample points and the biannual characterization of existing leachate sample points.

All methods are EPA approved and are fully described in the laboratory method and standard operating procedure documents. The laboratory may substitute EPA-approved methods upon notification and approval of the EP manager.

### **8. DATA QUALITY REVIEW, REPORTING, AND RECORD KEEPING**

Prior to the submittal of a monitoring report to the DOH, several data evaluation, reporting, and record keeping tasks will be implemented. The following sections, drawn extensively from the Guidance Document, describe the evaluation, reporting and record keeping procedures that should be followed upon receipt of an analytical report.

#### **8.1 DATA QUALITY REVIEW**

Each analytical report received from the laboratory should undergo two levels of quality assessment. These quality assessment procedures are described below.

##### **8.1.1 Initial QA/QC Checks**

Before data is subjected to statistical analysis, a qualified hydrogeologist or groundwater scientist should evaluate the data by examining the quality control information accompanying the data report from the laboratory. Relevant quality control data include measures of accuracy (percent recovery), precision (relative percent difference, RPD), and sample contamination (blank determinations). Data that fail any of these checks should be flagged for closer evaluation and a DQR. Results of the DQR should be submitted with the analytical data in the routine monitoring report (see

Laboratory Quality Control Procedures, for a description of DQR). A brief summary of relevant quality control data follows. A more complete description should be contained in the laboratory Quality Assurance Program Plan.

Accuracy defines the relationship between the laboratory's measurement of a sample's concentration and the "true", but unknown concentration of the sample. Because the "true" concentration is unknown, accuracy must be measured indirectly by determining the percent recovery of a sample called the matrix spike (MS). The MS is analyzed under the same conditions as the groundwater sample and its concentration is determined. Because the MS has a known concentration, its percent recovery can be calculated. It is assumed that the groundwater sample behaves exactly like the MS and thus the "true" concentration of the submitted groundwater sample can be back-calculated. Control criteria for percent recovery are taken from regulatory method requirements.

Precision is the assessment of the variability that can be expected in data resulting from the analytical procedures employed. It provides a measure of the reproducibility, which is estimated through duplicate measurements of a MS. Two MS samples are prepared as described above, an MS and a matrix spike duplicate (MSD). Both spikes are analyzed along with the unknown sample and the "relative percent difference" (RPD) between the two spikes is determined. Control criteria for RPD are taken from regulatory method requirements.

The potential for sample contamination is assessed by measurements of "blank" samples. Blanks are samples of ultra-pure laboratory water that are not spiked with any analytes and are carried through the field sampling and laboratory environments. These samples are known as "field," "lab," and "equipment" blanks. It is assumed that any analytes that occur in the field or laboratory, which might add to the concentration of the analyte in the sample, will be picked up by the blank samples and measured. If any of the analytes of interest are found in the blank samples, it is an indication of potential contamination of the unknown sample.

### **8.1.2 Qualitative Data Evaluation**

Following the initial QA/QC checks, all data should undergo a second level of review by graphing historical trends and comparing new results with these historical trends to flag visual outliers or other anomalous data. If a clearly anomalous result is found, a

DQR should be initiated with the laboratory to ascertain if laboratory error is involved. In addition, field information should be checked for anomalous occurrences or observations that might help to explain an outlier result.

## **8.2 DATA RECORD KEEPING REQUIREMENTS**

Following the initial QA/QC checks, all data should undergo a second level of review by graphing historical trends and comparing new results with these historical trends to flag visual outliers or other anomalous data. If a clearly anomalous result is found, a DQR should be initiated with the laboratory to ascertain if laboratory error is involved. In addition, field information should be checked for anomalous occurrences or observations that might help to explain an outlier result.

## **8.3 DATA REPORTING REQUIREMENTS**

Monitoring data should be submitted in reports that summarize all detection monitoring activities that took place during the preceding time periods in accordance with State and Federal regulations. A semi-annual/mid-year report will be submitted to the DOH detailing the results and events of the previous two monitoring periods. An annual report will be submitted to the DOH after the fourth quarter of each year summarizing monitoring activities for the entire preceding year. The annual report will include graphs of all analytical data from each monitoring point and background monitoring point, as required, except for those constituents for which no new data were collected since the previous graph submittal. Any deviations in sampling practices from the Guide shall be included in the monitoring reports, including a description of the deviation, reason for the deviation, affected well/sump location, and other pertinent information. Data will be submitted to DOH, County of Hawaii, Department of Environmental Management and WMH within 45 days of receipt of final data. Reports will include electronic version of the reports.

## 9. REFERENCES

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## TABLES

**Table 2-1**  
**Monitoring Well Construction Summary**  
**West Hawaii Sanitary Landfill**  
**North Kona, Hawaii**

Well No.	Installation Date	Northing (ft)	Easting (ft)	Top of Well Casing Elevation (ft above MSL)	Approximate casing stickup (ft above ground surface)	Screen Interval Elevation (ft below ground surface)		Screen Length (ft)	Casing Diameter (in)
						Top	Bottom		
WHW-01	Nov-93 to Dec-93	384,451.96	370,107.74	231.29	2.0	217.5	247.5	30	2
WHW-02	Oct-93 to Nov-93	383,403.53	369,650.96	213.09	2.0	199	229	30	2
WHW-03	Sept-93 to Oct-93	385,174.12	366,975.28	153.22	2.0	138	168	30	2
WHW-04	Dec-02 to Jan-03	N.A.	N.A.	163.26	N.A.	159	179	20 <sup>a</sup>	4
Production Well	Nov-93	N.A.	N.A.	191	N.A.	186	206	20	8

**Notes:**

Water levels in monitoring wells WHW-1, WHW-2, and WHW-3 are tidally influenced. Monitoring well WHW-4 was not installed at the time the tidal influence study was performed (April 2001). Reported water levels do not include averaging or compensation for tidal influence.

<sup>a</sup> Estimated based on Groundwater Well Completion Report WHW-04 (WMI 2003)

N.A. : Data not available

**Table 2-2**  
**Recent Groundwater Level Summary**  
**West Hawaii Sanitary Landfill**  
**North Kona, Hawaii**

Well No.	Elevation of Top of PVC Casing (ft MSL)	Sample Date	Depth to Groundwater Below Top of Casing (ft)	Groundwater Elevation (ft MSL)
WHW-01	231.29	1/27/1994	--	1.94
		3/21/1994	229.23	2.06
		6/20/1994	229.77	1.52
		8/11/1994	229.22	2.07
		9/20/1994	229.37	1.92
		1/27/1995	229.35	1.94
		3/14/1995	229.38	1.91
		4/13/1995	229.50	1.79
		6/22/1995	229.52	1.77
		12/15 & 16/2003	229.15	2.14
	231.27	6/21/2005	230.56	0.73
		12/19/2005	229.34	1.93
		6/6/2006	229.60	1.67
		6/26/2006	229.64	1.63
	231.31	12/4/2006	228.79	2.48
		6/19/2007	229.37	1.94
WHW-02	213.09	1/27/1994	--	1.69
		3/21/1994	211.21	1.88
		6/20/1994	211.63	1.46
		8/11/1994	211.10	1.99
		9/20/1994	211.26	1.83
		1/27/1995	211.40	1.69
		3/14/1995	211.22	1.87
		4/13/1995	211.39	1.70
		6/22/1995	211.40	1.69
		12/15 & 16/2003	NM	NM
	213.07	6/21/2005	212.50	0.59
		12/19/2005	211.12	1.95
		6/6/2006	211.45	1.62
		6/26/2006	211.45	1.62
	213.10	12/4/2006	210.65	2.42
		6/19/2007	211.22	1.88

**Table 2-2**  
**Recent Groundwater Level Summary**  
**West Hawaii Sanitary Landfill**  
**North Kona, Hawaii**

WHW-03	153.22	1/27/1994	--	1.47
		3/21/1994	151.63	1.59
		6/20/1994	152.10	1.12
		8/11/1994	151.52	1.70
		9/20/1994	151.68	1.54
		1/27/1995	151.75	1.47
		3/14/1995	151.68	1.54
		4/13/1995	151.83	1.39
		6/22/1995	151.79	1.43
		12/15 & 16/2003	151.27	1.95
		6/21/2005	151.52	1.70
		12/19/2005	151.67	1.55
		6/6/2006	152.01	1.21
		6/26/2006	151.89	1.33
		12/4/2006	151.03	2.19
		6/19/2007	151.69	1.82
**	153.51			
WHW-04	NM*	12/15 & 16/2003	161.28	--
	163.39	6/21/2005	161.97	1.42
		12/19/2005	161.59	1.80
		6/6/2006	161.95	1.44
	163.31	6/26/2006	161.64	1.75
		12/4/2006	160.94	2.45
		6/19/2007	161.58	1.73

Notes:

NM = Not Measured. Well WHW-4 was installed during 2002-2003.

-- = Data not available

\* No top of casing survey data or well construction details were available at the time

\*\* WHW-03 re-surveyed

**Table 3-1**  
**Leachate - Groundwater Concentrations Contrasts**  
**West Hawaii Sanitary Landfill**  
**Puuanahulu, North Kona, Hawaii**

Analyte of Interest	Leachate Point Exhibiting Maximum Concentration of Analyte of Interest <sup>[1]</sup>	Date of Maximum Leachate Concentration <sup>[1]</sup>	Maximum Leachate Concentration	Groundwater Background Concentration <sup>[2]</sup>	Units	Leachate/ Groundwater Ratio
Sulfate	SUMP-1	6/6/2006	130	196	mg/L	0.7
Lead*	SUMP-2	12/16/1997	5.5	5.0	ug/L	1.1
Thallium*	SUMP-2	12/16/1997	11.8	10.0	ug/L	1.2
Selenium*	SUMP-1	12/26/2001	6.2	5.0	ug/L	1.2
Barium*	SUMP-1	12/26/2001	295	200	ug/L	1.5
Bromide	SUMP-1	12/26/2001	17.6	7.9	mg/L	2.2
Vanadium*	SUMP-2	12/16/1997	465	191	ug/L	2.4
Sodium*	SUMP-1	6/16/1994	1440	585	mg/L	2.5
Chloride	SUMP-1	6/16/1994	2860	960	mg/L	3.0
Nickel*	SUMP-2	12/16/1997	137	40.0	ug/L	3.4
Solids, total dissolved (TDS)	SUMP-1	12/26/2001	7430	2020	mg/L	3.7
Magnesium*	SUMP-1	6/16/1994	382	82.6	mg/L	4.6
Nitrogen, nitrate	SUMP-2	12/16/1997	5.1	1.1	mg/L	4.6
Arsenic*	SUMP-1	12/26/2001	67.2	10.0	ug/L	6.7
Copper*	SUMP-1	6/16/1994	238	25.0	ug/L	9.5
Calcium*	SUMP-1	1/30/1997	337	35.2	mg/L	9.6
Potassium*	SUMP-1	12/26/2001	444	29.9	mg/L	14.8
Chromium*	SUMP-1	12/26/2001	161	10.0	ug/L	16.1
Sulfide	SUMP-1	12/26/2001	1.7	0.05	mg/L	34.0
Alkalinity, total (as CaCO <sub>3</sub> )	SUMP-1	12/26/2001	2980	72.7	mg/L	41.0
Alkalinity, bicarbonate (as CaCO <sub>3</sub> )	SUMP-2	12/16/1997	3380	79.2	mg/L	42.7
Chemical oxygen demand (COD)	SUMP-1	1/30/1997	1700	34.5	mg/L	49.3
Total organic carbon (TOC)	SUMP-1	1/30/1997	521	5.7	mg/L	92.2
Nitrogen, ammonia	SUMP-1	12/29/2000	390	3.5	mg/L	110.8
Manganese*	SUMP-1	1/30/1997	3.16	0.02	mg/L	210.7
Zinc*	SUMP-1	6/16/1994	7520	20.0	ug/L	376.0
Nitrogen, total kjeldahl (TKN)	SUMP-2	12/16/1997	387	1.0	mg/L	387.0
Iron*	SUMP-2	12/19/1996	82.2	0.10	mg/L	822.0
Antimony*	N/A	N/A	ND <sup>[3]</sup>	60.0	ug/L	NM <sup>[4]</sup>
Beryllium*	N/A	N/A	ND	5.0	ug/L	NM
Cadmium*	N/A	N/A	ND	5.0	ug/L	NM
Cobalt*	N/A	N/A	ND	50.0	ug/L	NM
Cyanide, total	N/A	N/A	ND	0.02	mg/L	NM
Mercury*	N/A	N/A	ND	0.20	ug/L	NM
Silver*	N/A	N/A	ND	25.0	ug/L	NM
Tin*	N/A	N/A	ND	200	ug/L	NM

**Notes:**<sup>[1]</sup> based on data through the first half of 2007<sup>[2]</sup> based on statistical prediction limit of background data set through the first half of 2007<sup>[3]</sup> ND = analyte not detected in any leachate samples<sup>[4]</sup> NM = ratio not meaningful because leachate data sets contain no detections of this parameter

\* Note that contrast evaluation compares the "total" concentration of a metal in leachate to the "dissolved" concentration in groundwater

**Table 3-2**  
**Detection Monitoring Program Parameters**  
**West Hawaii Sanitary Landfill**  
**Puuanahulu, North Kona, Hawaii**

	Frequency	Locations
<b><u>GROUNDWATER</u></b> <b>Detection Monitoring Parameters</b> Volatile Organic Compounds (VOCs) – EPA 8260B Parameters Total Organic Carbon (TOC) Dissolved Potassium Bicarbonate Alkalinity	Semi-Annual	WHW-01, WHW-02, WHW-03, WHW-04
<b>Supplemental Monitoring Parameters</b> Bromide Chloride Sulfate Dissolved Calcium Dissolved Magnesium Dissolved Sodium Total Dissolved Solids (TDS)	Semi-Annual	WHW-01, WHW-02, WHW-03, WHW-04
<b>Groundwater Characterization Parameters</b> (1) detection monitoring parameters, above (2) supplemental geochemical parameters, above (3) Subtitle D Appendix II parameters, below 17 "dissolved" and "total" trace metals: Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Tl, Sn, V, Zn Cyanide, total Total Sulfide Semivolatile Organic Compounds Pesticides Herbicides PCBs	Once, upon installation	Any Newly Installed Wells
<b><u>LEACHATE</u></b> <b>Routine Leachate Monitoring Parameters</b> Alkalinity (includes total, bicarbonate, and carbonate) Bromide Chloride Sulfate Calcium, total Magnesium, total Potassium, total Sodium, total Total Dissolved Solids (TDS) Total Organic Carbon (TOC) VOCs (EPA Method 8260B analytes)	Annually	Sump-1, Sump-2
<b>Non-Routine Leachate Characterization Parameters</b> 17 "total" trace metals: Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Tl, Sn, V, Zn Cyanide, total Total Sulfide Semivolatile Organic Compounds Pesticides Herbicides PCBs Major cations and anions (covered by routine monitoring, above) – (Mg, Na, Ca, K, Cl, carbonate, sulfate, and bicarbonate) Major leachate indicators (partially covered by routine monitoring, above) – (TDS, TOC, Total Alkalinity, Nitrogen-Ammonia, Cl, Fe) Field measurements (performed in accordance with Sampling and Analysis procedures in Section 5.0) – (electrical conductance, pH, temperature, and turbidity)	Biennially	Sump-1, Sump-2

**Table 7-1**  
**Analytical Methods for the Routine Analysis of Groundwater and Leachate**  
**West Hawaii Sanitary Landfill**  
**Puuanahulu, North Kona, Hawaii**

Parameter	Parameter Type	Method
Dissolved Potassium	Detection Monitoring Parameter	SW-846 6010B
Total Organic Carbon (TOC)	Detection Monitoring Parameter	MCAWW 415.1
VOCs	Detection Monitoring Parameter	EPA 8260B
Alkalinity (including total, bicarbonate, and carbonate)	Detection Monitoring Parameter	MCAWW 310.1
Bromide	Supplemental Geochemical Parameter	MCAWW 300.0A
Chloride	Supplemental Geochemical Parameter	MCAWW 300.0A
Sulfate	Supplemental Geochemical Parameter	MCAWW 300.0A
Dissolved Calcium	Supplemental Geochemical Parameter	SW-846 6010B
Dissolved Magnesium	Supplemental Geochemical Parameter	SW-846 6010B
Dissolved Sodium	Supplemental Geochemical Parameter	SW-846 6010B
Total Dissolved Solids (TDS)	Supplemental Geochemical Parameter	MCAWW 160.1

**Notes:**

(A): Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, EMSL, Cincinnati, OH (Revision March 1983).

(B): Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update 0.

**Table 7-2**  
**Analytical Methods for the Characterization of Groundwater from Newly Installed Wells**  
**West Hawaii Sanitary Landfill**  
**Puuanahulu, North Kona, Hawaii**

Parameter	Parameter Type	Method
Dissolved Potassium	Detection Monitoring Parameter	SW-846 6010B
Alkalinity (including total, bicarbonate, and carbonate)	Detection Monitoring Parameter	MCAWW 310.1
Total Organic Carbon (TOC)	Detection Monitoring Parameter	MCAWW 415.1
VOCs	Detection Monitoring Parameter	SW-846 8260B
Bromide	Supplemental Geochemical Parameter	MCAWW 300.0A
Chloride	Supplemental Geochemical Parameter	MCAWW 300.0A
Sulfate	Supplemental Geochemical Parameter	MCAWW 300.0A
Dissolved Calcium	Supplemental Geochemical Parameter	SW-846 6010B
Dissolved Magnesium	Supplemental Geochemical Parameter	SW-846 6010B
Dissolved Sodium	Supplemental Geochemical Parameter	SW-846 6010B
Total Dissolved Solids	Supplemental Geochemical Parameter	MCAWW 160.1
17 Trace Metals (dissolved): Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Tl, Sn, V, Zn	Subtitle D Appendix II	(1) SW-846 6010B: Sb, As, Ba, Be, Cr, Co, Pb, Tl, Sn, V, Zn
		(2) SW-846 6020: Cu, Cd, Ni, Se, Ag
		(3) SW-846 7470A: Hg
Cyanide, total	Subtitle D Appendix II	SW-846 9012A
Total Sulfide	Subtitle D Appendix II	SW-846 9030B/9034
Semi-Volatile Organics	Subtitle D Appendix II	SW-846 8270C
Organochlorine Pesticides	Subtitle D Appendix II	SW-846 8081A
Chlorinated Herbicides	Subtitle D Appendix II	SW-846 8151A
PCBs	Subtitle D Appendix II	SW-846 8082
Organophosphorus Pesticides	Subtitle D Appendix II	SW-846 8141A

**Notes:**

(A): Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, EMSL, Cincinnati, OH (Revision March 1983).

(B): Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update 0.



**Table 7-3**  
**Analytical Methods for the Initial and Biennial Characterization of Leachate**  
**West Hawaii Sanitary Landfill**  
**Puuanahulu, North Kona, Hawaii**

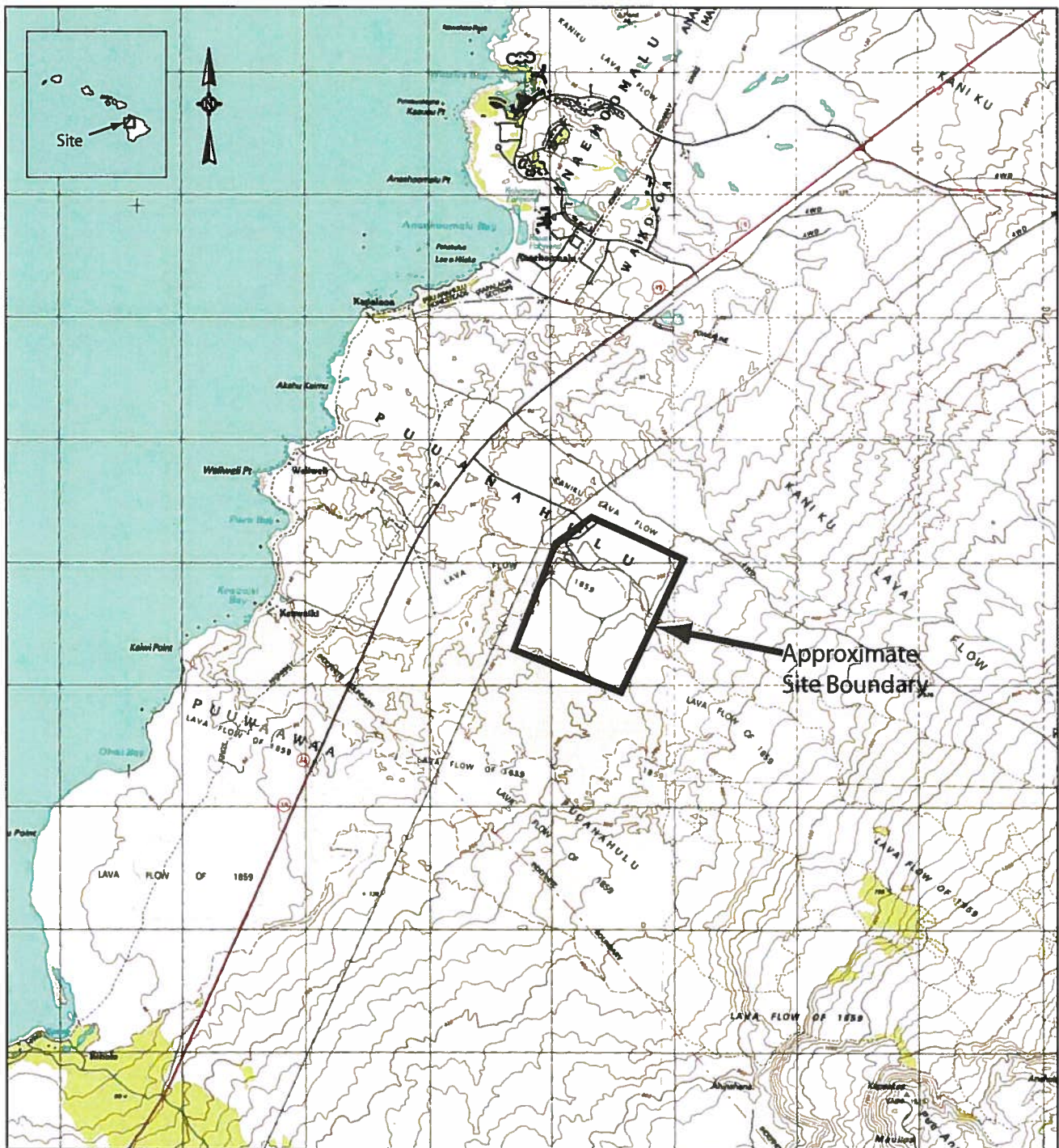
<b>Parameter</b>	<b>Parameter Type</b>	<b>Method</b>
Potassium (total)	Detection Monitoring Parameter	SW-846 6010B
Total Organic Carbon (TOC)	Detection Monitoring Parameter	MCAWW 415.1
VOCs	Detection Monitoring Parameter	SW-846 8260B
Alkalinity (reported as total, bicarbonate, and carbonate)	Detection Monitoring Parameter	MCAWW 310.1
Bromide	Supplemental Geochemical Parameter	MCAWW 300.0A
Chloride	Supplemental Geochemical Parameter	MCAWW 300.0A
Sulfate	Supplemental Geochemical Parameter	MCAWW 300.0A
Calcium (total)	Supplemental Geochemical Parameter	SW-846 6010B
Magnesium (total)	Supplemental Geochemical Parameter	SW-846 6010B
Sodium (total)	Supplemental Geochemical Parameter	SW-846 6010B
Total Dissolved Solids (TDS)	Supplemental Geochemical Parameter	MCAWW 160.1
17 Trace Metals (total): Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Tl, Sn, V, Zn	Subtitle D Appendix II	(1) SW-846 6010B: Sb, As, Ba, Be, Cr, Co, Pb, Tl, Sn, V, Zn (2) SW-846 6020: Cu, Cd, Ni, Se, Ag (3) SW-846 7470A: Hg
Cyanide, total	Subtitle D Appendix II	SW-846 9012A
Total Sulfide	Subtitle D Appendix II	SW-846 9030B/9034
Semi-Volatile Organics	Subtitle D Appendix II	SW-846 8270C
Organochlorine Pesticides	Subtitle D Appendix II	SW-846 8081A
Chlorinated Herbicides	Subtitle D Appendix II	SW-846 8151A
PCBs	Subtitle D Appendix II	SW-846 8082
Organophosphorus Pesticides	Subtitle D Appendix II	SW-846 8141A
Ammonia-Nitrogen	Guidance Document	MCAWW 350.1
Iron, total	Guidance Document	SW-846 6010B

**Notes:**

(A): Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, EMSL, Cincinnati, OH (Revision March 1983).

(B): Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition,

## FIGURES



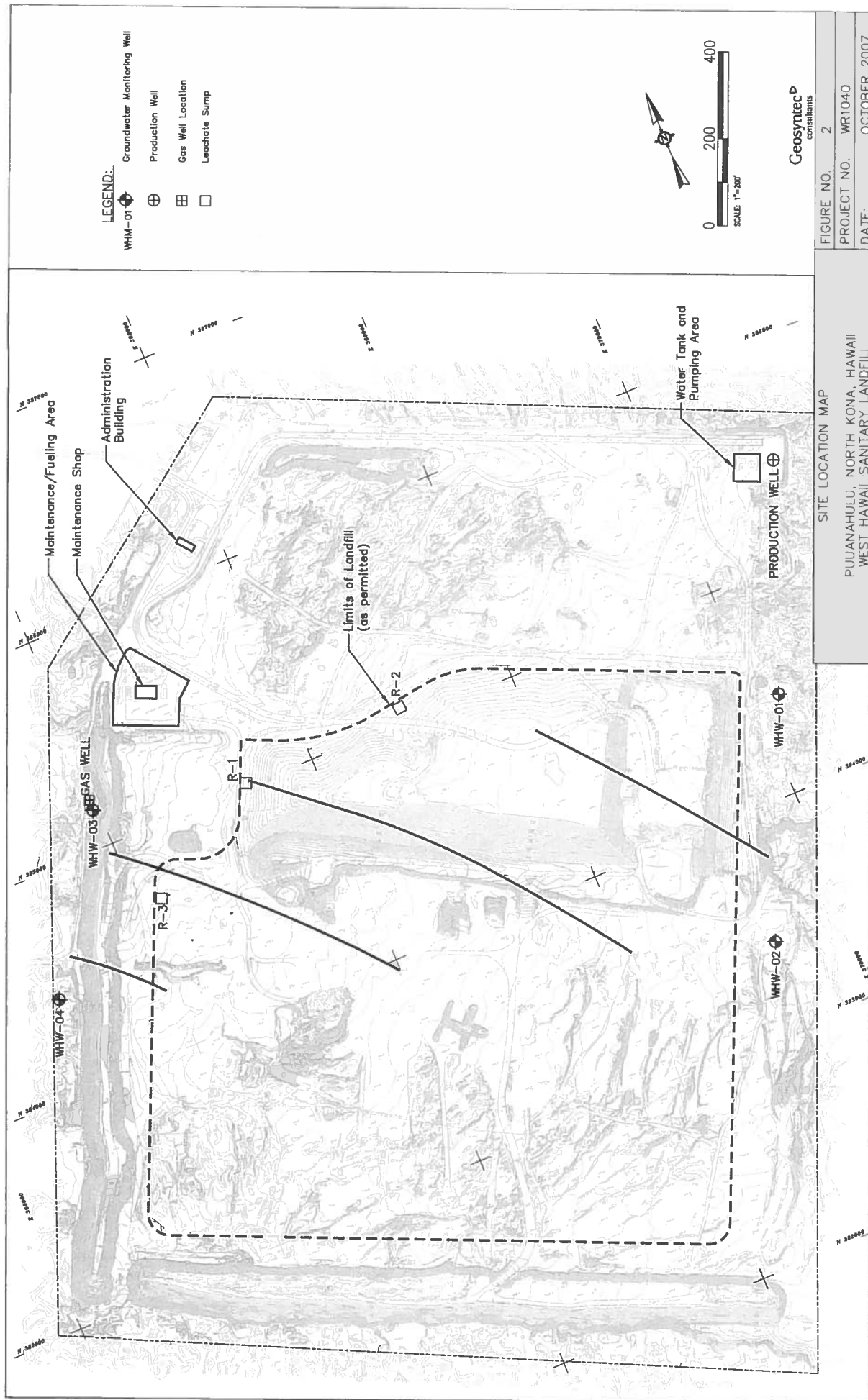
Topo Source: U.S.G.S. 7.5 Minute Series,  
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 APPROX.  
 SCALE IN FEET

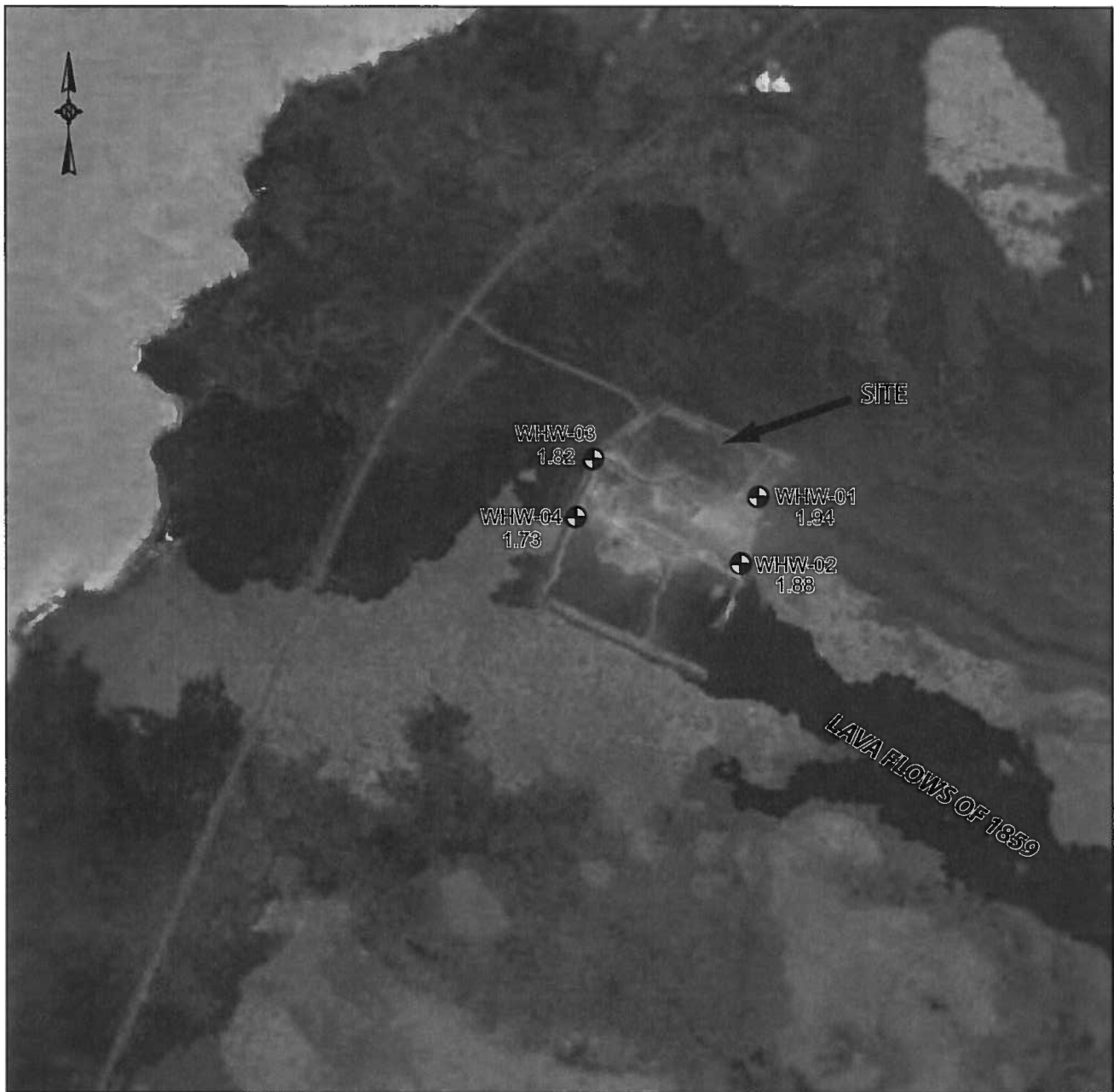
**Geosyntec**  
 consultants

SITE LOCATION MAP  
 WEST HAWAII SANITARY LANDFILL  
 PUUANAHULU, NORTH KONA, HAWAII

FIGURE NO.	1
PROJECT NO.	WR1040
DATE:	OCTOBER 2007







● WHW-01 Groundwater Monitoring Well  
 1.94 Groundwater Elevation (ft MSL)

Aerial Source: Google Earth

Notes:

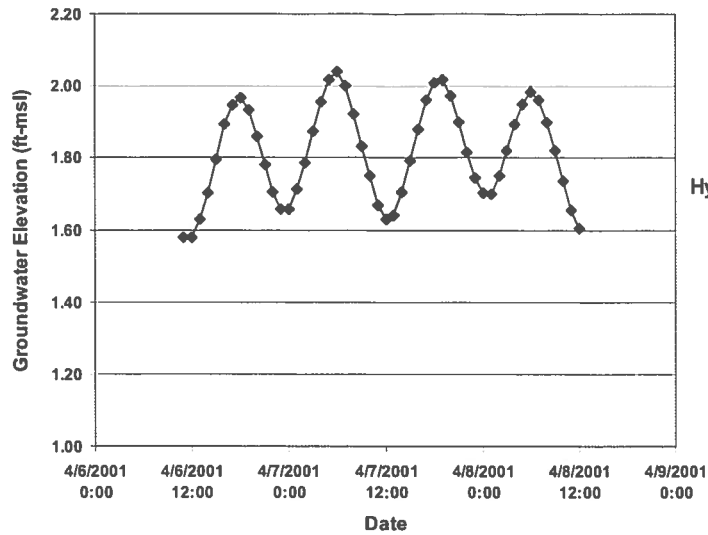
1. Well Locations are Approximate
2. Posted values are general groundwater elevations  
(feet above mean sea level)

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 SCALE IN FEET

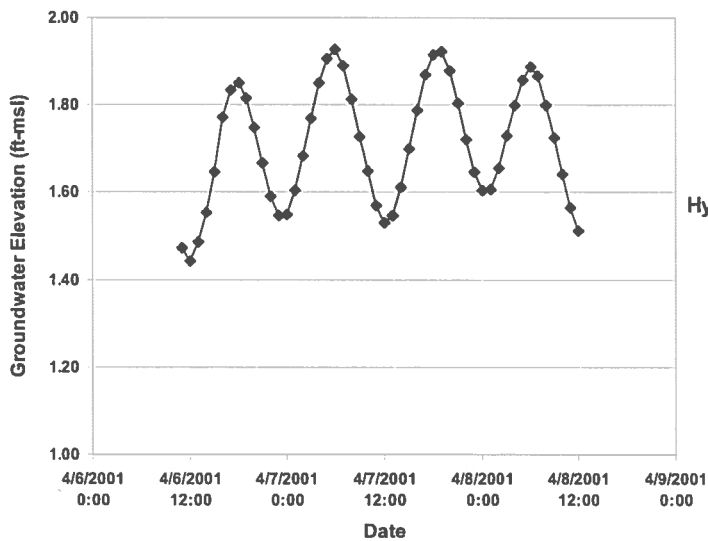
**Geosyntec**  
 consultants

AERIAL PHOTO WITH APPROXIMATE  
 GROUNDWATER ELEVATIONS  
 WEST HAWAII SANITARY LANDFILL  
 PUUANAHULU, NORTH KONA, HAWAII

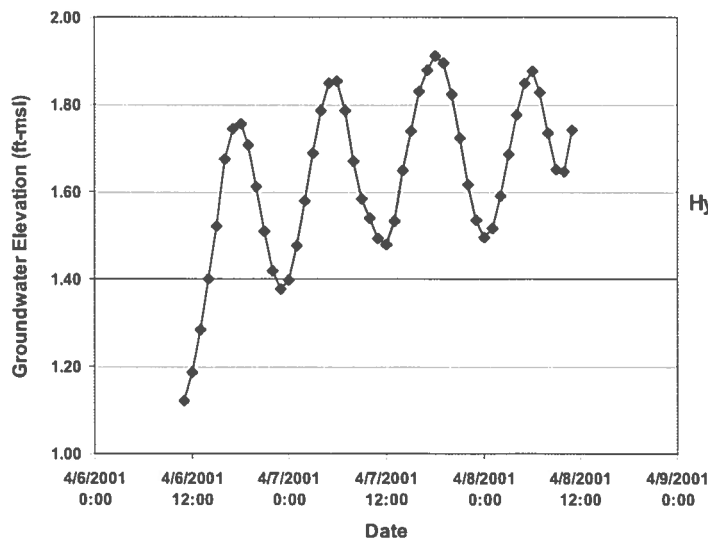
FIGURE NO.	3
PROJECT NO.	WR1040
DATE:	OCTOBER 2007



Hydrograph WHW-01



Hydrograph WHW-02



Hydrograph WHW-03

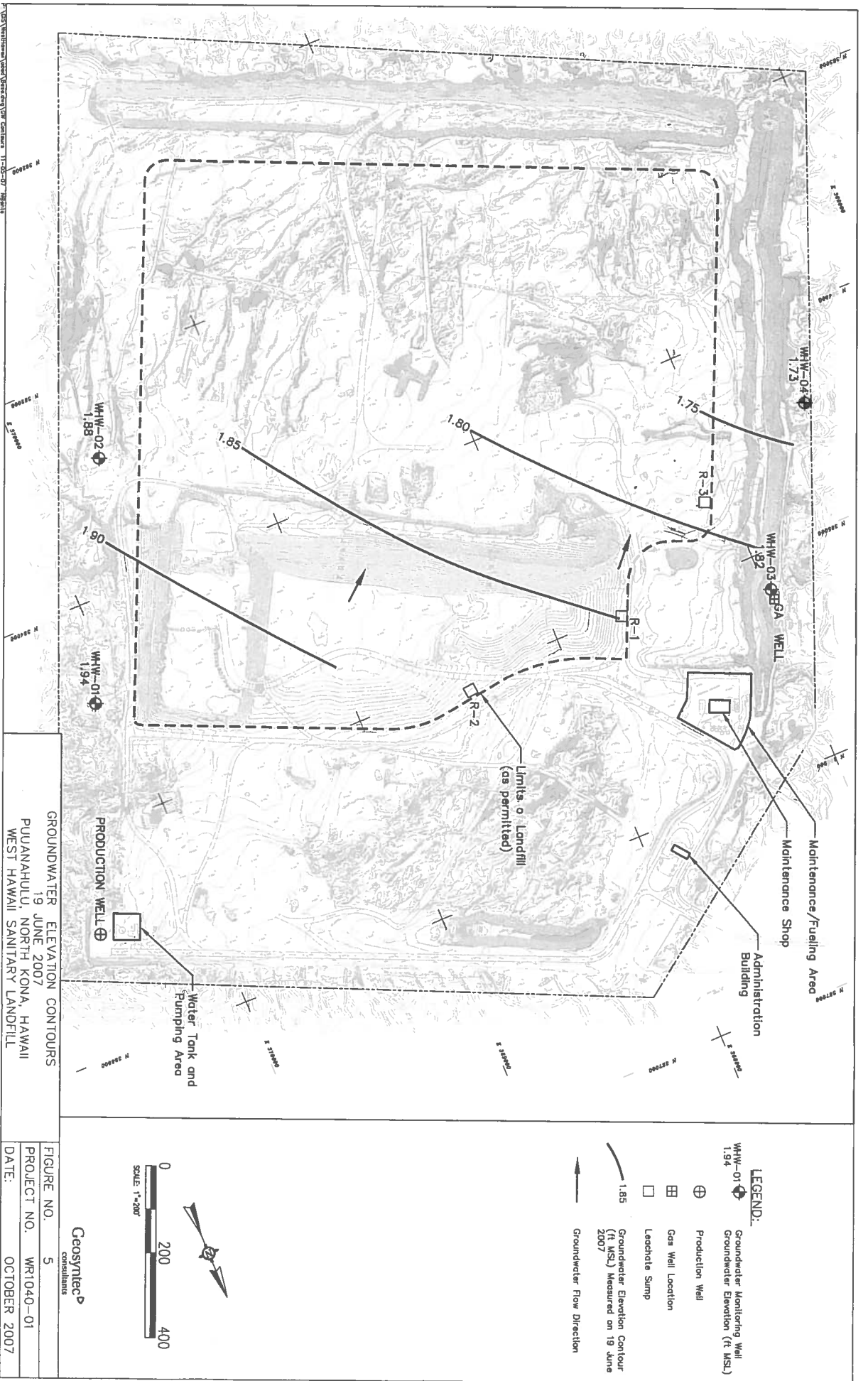
Geosyntec<sup>®</sup>  
consultants

**HYDROGRAPH ILLUSTRATING APRIL 2001  
TIDAL INFLUENCE STUDY RESULTS  
WEST HAWAII SANITARY LANDFILL  
PUANAHULU, NORTH KONA, HAWAII**

Figure Number: 4

Date: October 2007

Project Number: WR1040



## APPENDIX A



# **GROUNDWATER, SURFACE WATER, & LEACHATE SAMPLING GUIDE**

**March 5, 2004**

Version 1.0

Prepared by:

Waste Management, Inc.  
Groundwater Protection Program



# **GROUNDWATER, SURFACE WATER, AND LEACHATE SAMPLING GUIDE**

## **1.0 SAMPLING GUIDE OVERVIEW**

The Groundwater, Surface Water, and Leachate Sampling Guide (Guide) represents the general requirements for groundwater, surface water, and leachate sample collection at sites owned and/or operated with environmental responsibility by Waste Management (WM). This guide is derived, in part, from the guidelines set forth in the following ASTM Environmental Standards:

**ASTM Standard D1129-90, (1990) Terminology Related to Water**

**ASTM Standard D3370-82, (1989) Standard Practices for Sampling Water**

**ASTM Standard D4840-88, (1993) Practice for Sampling Chain of Custody  
Procedures**

**ASTM Standard D3694-93, (1993) Practices for Preparation of Sample Containers  
and for Preservation of Organic Constituents**

**ASTM Standard D5088-90, (1993) Practice for Decontamination of Field Equipment  
Used at Non-Radioactive Waste Sites**

This Guide may be supplemented based on site-specific conditions and/or State specific requirements, which preclude strict adherence to the Guide as described herein. Possible reasons for variation from this Guide include, but are not limited to, unusual site hydrogeologic conditions (e.g. low permeability formations resulting in long recharge times), and State-specific or permit-specific requirements that significantly differ from this Guide.

The site sampling technician and/or consultant (sampling team) is responsible for the proper collection of samples at groundwater sampling points, piezometers, surface water locations, and leachate sample points at WM facilities. The sampling team must be familiar with the contents of this Guide prior to the initiation of a sampling event. The sampling team is also responsible for ensuring that all sampling requirements described in the site's operating permit, approved monitoring plan (by site or regulator, as applicable), local regulations, and any other associated documents are complied with in full.

Each WM facility will have a designated person responsible for implementing the groundwater-monitoring program. This person may be identified as a Site Manager, Engineering Manager, Compliance Manager, Corporate Hydrogeologist, or other designee. The WM representative should provide oversight to ensure that the final sample results satisfy both WM's minimum requirements and the appropriate State regulatory requirements. It is the responsibility of the sample team leader to confer with the designated representative of WM prior to initiation of

sampling. The sampling team is responsible for meeting all safety related regulatory requirements when sampling groundwater and should meet with the site manager prior to sampling to identify and address any site-specific safety requirements.

It is the WM representative's responsibility to ensure that sampling is conducted as required by any site-specific permits and regulatory requirements, and that those requirements are communicated to the sampling team. It is the sampling teams' responsibility that sampling methodologies and protocol are performed in accordance with the applicable permits, all federal, State, or local regulations, and this Guide.

Questions or comments on the Guide should be directed to the designated WM representative or to the WM Corporate Manager of Hydrogeology that is responsible for oversight at the respective facility(s).

## **2.0 SAMPLING GUIDE REVIEW REQUIREMENT**

This Guide should be reviewed and signed by all sampling team members prior to initiation of routine or special groundwater sampling events at all WM sites. All well construction information and documentation of completed sampling events should be filed and available at the site. All sampling team members must sign a Signature Page, verifying that they have read and understand this Guide and note any exceptions to the Guide. A copy of the Signature Page is presented in Attachment 1.

Site conditions or site-specific regulatory requirements may necessitate a deviation from the Guide as described herein. Any such deviation from this Guide must be documented by the sampling team leader in coordination with the Engineering Manager, Compliance Manager, or other designated WM representative. The Signature Page requires updating whenever there is a new sampling team, sampling team member, or there are documented changes to sampling program that affect this protocol.

### 3.0 SAMPLING EQUIPMENT, PRE-SAMPLING PROCEDURES, AND DOCUMENTATION

Before any sampling is performed at a facility, a number of preliminary tasks must be completed. These tasks include reviewing the site permit and approved site-specific groundwater monitoring plan, identifying well locations and characteristics, verifying the sampling schedule, reviewing the laboratory addenda, identifying the parameters to be analyzed, and identifying sampling point order (i.e. unimpacted wells first). The WM representative is responsible for approving the site-specific laboratory addenda, which details the sampling and analyses required for each event. The laboratory addenda specify the sample point identification, analytical requirements (analytes and methodology and holding times), frequency (i.e. event schedule), and required reporting limits. It is the responsibility of the sampling team to complete all preliminary sampling tasks including coordinating timely sample set delivery from the laboratory, calibrating field meters and equipment, inspecting coolers and bottles sets, initiating Chain-of-Custody records and obtaining the proper Field Logs/Field Information Forms. It is suggested that preparation begin at least two weeks prior to the event to provide the sample team and the analytical laboratory enough time to complete all of the steps addressed in this Guide and to address any problems that may occur. For unplanned or emergency events, contact the laboratory and/or WM for help on abbreviating or special event procedures. A copy of the Special Event Notification Form is presented in Attachment 2.

#### 3.1 Equipment and Materials

All non-dedicated field equipment should be cleaned and/or decontaminated, checked to ensure that it is functioning properly and calibrated before going into the field. Quality Control procedures (e.g. equipment blanks) are discussed in Section 4.2.5.

##### 3.1.1 Pumps

The specific pump used depends on site conditions and type of analyses being performed. Dedicated displacement bladder pumps constructed of Teflon and stainless steel or PVC are preferred for most sampling programs. QED Well Wizard® pumps are the WM requisite sampling system for most sites. Pumps without check valves, or other mechanisms to prevent backflow should not be used during purging. A representative of WM should be informed of any well network not utilizing dedicated bladder pumps. It is the WM representative's responsibility to arrange for and/or provide direction for purchase and installation of dedicated pumps. Placement of the sampling pump is critical for proper sampling. The pump inlet should be set as close to the middle of the well screen as possible. If requested to install a pump, it is the sampling team's responsibility to ensure that proper quality control procedures are followed when installing a pump and that pumps are not contaminated during installation. Associated documentation is maintained in field notes and/or Field Information Forms (see Section 3.4). The certification tags on each Well Wizard pump should be retained on-site with other site-specific sampling documentation for future reference.

Non-dedicated pumps must only be used on a temporary basis with approval from the designated WM representative. When non-dedicated pumps or sampling devices are used, stringent cleaning

procedures must be followed between sampling locations (see Section 3.2). Equipment blanks must also be obtained in accordance with Section 4.2.5 of this Guide.

### 3.1.2 Bailers

Bailers are only to be used on a temporary basis if no other sampling equipment is available or if otherwise approved by an authorized WM representative (e.g. if there is inadequate volume to use a pump). Bailers should be made of suitable inert materials (such as stainless steel, PVC, or Teflon), when monitoring for organic compounds. Stainless steel or Teflon bailers should be used for such applications as "oily" matrices where ease of cleaning and durability may be a factor. PVC bailers with non-glued joints may also be used. Non-dedicated/reusable bailers shall not be used unless specific approval has been obtained from a WM representative.

When bailers are used, the bailer cord shall be fastened securely to the bailer and shall be constructed of nylon, stainless steel, or polypropylene, and be specifically manufactured for use in the collection of environmental samples. This cord must be new, clean, and in good condition. Rope, twine or other "off-the-shelf" cord shall not be used for securing the bailer. Care should be taken not to excessively disturb the column of water in the well casing. Gently lower the bailer into the well with each cycle. The sampler's knowledge of the depth to water will help in this regard. Attempt to lower the bailer into the water only to the extent necessary to fill or nearly fill the chamber. Avoid submerging the top of the bailer.

When used, non-dedicated bailers must be thoroughly decontaminated (see Section 3.2) and triple-rinsed with deionized water (or laboratory reagent water) before and after sampling at each location. Equipment blanks must also be obtained in accordance with Section 4.2.5 of this Guide.

Dedicated bailers should be rinsed with distilled water prior to beginning purging, but require no additional decontamination.

### 3.1.3 Sample Coolers and Sample Bottles

The sampling team should confirm shipment and check all sample containers and sample coolers for broken bottles and proper preservatives when received. The designated WM representative is responsible for arranging sample container shipment from the laboratory in a timely manner (at least two weeks in advance) and for ensuring that the laboratory has the correct shipping address/location. The sampling team is also responsible for obtaining proper ice packs (e.g. frozen ice packs) prior to the sampling event. Filtering requirements and bottle type should be corroborated with the site permit and approved Groundwater Monitoring plan. The sampling team must communicate with site personnel to ensure access to the facility before the sampling event so that the event may proceed on schedule, and equipment, sample coolers, and supplies may be checked to verify completeness of bottle order and proper operation of field equipment. (Note: It is important that sample coolers and bottles be stored, transported, and handled in a manner that prevents exposure to solvents, cleaners, gasoline, diesel fuels, exhaust, or other potential contaminants.)

Upon receipt, an inventory of the coolers and bottles and their condition should be noted in field notes and documented on the Field Information Form. Each sample bottle is provided with its

own bottle I.D., which refers to the laboratory group, filtering requirements, necessary preservatives, sample point/location, analytical method, and bottle size. This information must be checked, verified, and included on Field Information Forms and Chain-of-Custody records. Should an error occur within the bottle set, the laboratory must be notified immediately.

The laboratory will provide and determine the proper number of sample containers in each sample cooler, unless otherwise specified or requested by the WM representative. The type of bottle will vary depending on the analysis required. With the exception of bottles for Volatile Organic Analyses (VOA), samples requiring preservation in the field will have an associated preservative supplied in separate containers. VOA containers will be pre-preserved at the laboratory. Each sample bottle either is provided with a label or is labeled with a sticker to identify the preservative required. It is the sample team's responsibility to ensure that the appropriate preservatives are added in the field (see Section 7.1). Preservatives must not be added to bottles that do not require them.

Each sample cooler that includes bottles for volatile organic analyses must include a Trip Blank (see Section 4.2.5 of this Guide) unless otherwise specified by the WM representative. When volatile organic analyses have been requested, the sample cooler will contain a Trip Blank regardless of whether a request has been placed for analysis of the Trip Blank. An effort to pack all VOAs in one cooler should be made to reduce trip blank costs. Prior to shipment, the Laboratory checks each Trip Blank vial to ensure that it has no air bubbles. If large (i.e. pea sized) bubbles are present utilize the initial trip blank and note the bubble size on the field information forms.

Empty bottles will be included within the sample cooler for Field Blanks (duplicates and equipment blanks if necessary) analyses (see section 4.2.5). The sampling team should coordinate with the laboratory to identify the number of Field Blanks required for sampling. Duplicates will be analyzed on an as-requested basis only.

The sample cooler will not contain ice packs upon receipt from the laboratory. WM requires the use of frozen ice (wet ice in bags) to maintain sample temperature at the levels required by EPA methods during shipment of samples back to the laboratory. It is the sampler's responsibility to ensure that ice packs are available to cool samples upon collection. Furthermore, the sampling team is responsible to ensure that provisions have been made in advance for those facilities that do not have accommodations to maintain ice packs. In such cases, it is recommended to bring pre-chilled coolers and extra ice packs to the site.

### **3.2 Decontamination Procedures for Non-Dedicated, Down-Hole Equipment**

All non-dedicated, sample-contacting and down-hole equipment must be thoroughly decontaminated prior to its use in sample collection activities. This includes non-dedicated pumps, non-dedicated bailers, groundwater level measurement devices, field parameter measurement devices and non-dedicated filtering apparatuses. Each sample team shall have a water level probe that is dedicated to groundwater monitor well use only. Unless otherwise required, no other non-dedicated downhole equipment should be used during sampling. Under no

circumstances shall the groundwater level measuring probe be used to measure other liquid levels (such as leachate or grossly contaminated wells).

Decontamination procedures of down-hole equipment must, at a minimum, consist of washing with a non-phosphate detergent solution followed by a series of rinses (i.e. 2 to 3) with control water (i.e. water of a known chemistry) and one rinse with deionized water. Decontamination of non-dedicated pumps must, at a minimum, consist of circulation of three pump and tubing volumes of clean water through the pump system and all associated discharge tubing at separate stations. A series of three pre-cleaned liquid storage containers will aid in this respect. The first container should contain a non-phosphate detergent solution. The remaining two should consist of water of a known chemistry. Other non-dedicated equipment (e.g. field meters and water level indicators) should be triple rinsed with deionized (DI) water before and after each use.

Equipment Blanks must be collected from non-dedicated purging/sampling equipment following decontamination based on a schedule of one sample for each day of sample collection (see Section 4.2.5). Equipment Blanks will be analyzed for all sample matrices, analytical tests, and equipment configurations.

### **3.3 Calibration and Use of Meters**

The proper measurement and documentation of field analyses are a critical part of the monitoring program. Before going to the field, all equipment must be cleaned and checked for any malfunctions. The sampling team must calibrate all meters each morning before using them in the field following manufacturers' and/or EPA (or appropriate State agency) calibration procedures. In the absence of manufacturer guidelines or where required by regulation (e.g. NPDES Sampling), use the appropriate EPA procedures for equipment calibration (e.g. Standard Methods for Chemical Analysis of Waters and Waste Waters, attached for pH, temperature, turbidity, conductance, and dissolved oxygen). Some field analytical methods and/or regulatory agencies have specific calibration procedures which sampling teams may be required to follow. Sampling teams should verify with the WM representative if such procedures exist.

Equipment calibration shall be conducted daily at a minimum. Calibration solutions must be freshly prepared or bottled from non-expired stock. In the absence of manufacturer or regulatory guidance, field equipment should be calibrated to within  $\pm 5\%$  of the standard (or 0.1 standard units for pH meters). Calibration of field specific conductance should be verified against a chilled standard to verify temperature compensation. Equipment that fails calibration should be taken out of service and replaced or repaired prior to sampling. It is recommended that calibration checks be conducted periodically (e.g. mid-day and at the end of the day) to document any instrument drift. If there is significant instrument drift (e.g.  $>10\%$  or 0.2 standard units for pH) then the meters should be recalibrated. In all cases, it is the sampling team's responsibility to ensure proper documentation of all calibration procedures for each sampling event, including calibration methodology (one or two point calibration), calibration measurements, source of standard, standard concentration(s) and expiration date, and any discrepancies.

It is the sampling team's responsibility to document the calibration of field instruments and verify that field instruments are performing within design parameters for the instrument. Sampling



should not occur if field instruments are not working properly. Verification of field meter calibration is to be recorded on the Meter Calibration Log, included in Attachment 5. Meter Calibration Logs should be maintained and kept with the Field Information Form and Chain-of-Custody form for each sampling event. These forms may be maintained separately on site as requested by WMI.

### 3.3 Field Record Keeping

Proper chain-of-custody documentation is a crucial part of the monitoring program's quality assurance and quality control (QA/QC). Comprehensive, consistent, and accurate documentation of field tests, measurements, decontamination procedures, meter calibration, and field observations is extremely important.

During each sampling event, the sampling team must fill out two forms: a Field Chain-of-Custody Record and a Field Information Form. The original (white) copy of each form must be sent with the samples to the laboratory. **Under no circumstances should samples be shipped or analyzed without these forms.** The forms are returned to WM with the analytical report. Copies of all forms (e.g. yellow copy) are also to be maintained at the site and/or Region Office for easy reference. Sample teams should keep a copy of the forms (e.g. pink) for their records. Examples of the approved Chain of Custody's and WM Field Information Forms are provided as Attachment 3.

All field notes and forms must be completed with indelible black or blue ballpoint ink only. Pencils and felt-tip pens should not be used. Corrections should be made by striking through the error with a single line, writing in the correction, and dating and initialing the change. White out, erasures, or obliterations are not acceptable and will be brought to the attention of WM by the analytical laboratory.

### 3.4 Field Notes

#### 3.4.1 Field Information Forms

The Field Information Form contains information regarding site and well conditions, sampling and purging procedures, and field measurements. The Field Information Form must be filled out by the sampling team for each sample point and a copy placed along with the Chain-of-Custody Record in the cooler(s) shipped to the laboratory. At a minimum, the following **must be documented** on Field Information Forms:

- **Site Information:** Site Name, Site Number (from the WM Representative), and Sample Point
- **Purging Information:** Date, time, elapsed time, water volume in casing (for a 3-volume purge), required purge volume, and actual volume purged
- **Purging and Sampling Equipment:** Dedicated equipment, pump type, tubing material, filter type and size, etc. Use these fields to record when a sample is field filtered, the filtering method, brand name, and the pore size of the filter.
- **Well Data:** Sample point elevation (use State/permit specified datum (e.g. NGVD), depth to water or fluid, and calculated fluid/groundwater elevation are required. Total depth (when required) stickup, and casing diameter and material should also be noted.

- **Stabilization Data:** depth to fluid elevation and field measurements should be recorded to verify parameter stabilization or once per each casing volume for a multiple volume purge.
- **Field Data:** Sample date, and the final field measurements, prior to sampling, should be recorded in this section. Other field parameters such as dissolved oxygen, turbidity, and redox potential (note the unit value) should also be recorded, as necessary.
- **Field Comments:** Field observations should be recorded as noted in Section 3.4.2

The Field Information Form has optional fields for recording parameter stabilization data during minimal drawdown sampling or for recording multiple field measurements as required by sampling protocol (e.g. a 3 volume purge) or by permit. Section 3.5 provides a more detailed discussion on collecting field measurements and Section 4.0 provides more detail for recording purge data.

#### 3.4.2 Comments

The **Field Comments** section of the Field Information Form should include observations such as:

- Problems with condition of the well and/or dedicated equipment, such as a cracked cement pad or surface seal, malfunctioned or missing lock, broken protective casing, ponded water, cracked or bent pump/tubing, well obstructions, etc. WM should be notified immediately if the damage to the well is severe enough to affect sampling.
- Weather conditions: wind direction, speed, upwind activities (ensure that vehicles/gasoline compressors are not upwind of sampling activities), temperature, and barometric pressure (as required by permit or regulation).
- Sample Appearance including odor, color, and turbidity,

Odor: e.g. rotten eggs, earthy, strong, moderate, slight (do not sniff sample). Describe the characteristics of the odor, do not speculate as to the cause of the odor.

Color: True "color" is the color after turbidity has been removed, if samples are filtered. True color may be caused by metallic ions, humus, peat, or industrial chemicals. Hold the sample up to the light and describe the true color in as much detail as possible (color charts are acceptable descriptive methods). If samples are not filtered, then color may be a function of turbidity.

Turbidity: (regardless of whether turbidity measurements are taken):

None: sample is clear.

Trace: sediment slightly clouds or colors the sample; sediment does not accumulate in the bottle.

Moderate: definite cloudiness, sediment accumulates at the bottom of sample bottle.

High: muddy/dark brown appearance.

In general, a turbidity-measuring device should be used and measurements be provided in nephelometric turbidimetry units (NTU's). Section 4.2.1 provides additional guidance on turbidity.

Record all calculations for purge volumes (see Attachment 4) and temperature conversions. Note when wells are purged dry or why the requisite casing volumes were not removed (not applicable for low flow sampling). Other factors, such as collection of a duplicate sample, field blanks, sample splits with regulatory agencies, potential safety or health hazards (e.g. fire ants, bees, presence of landfill gas in well) should be noted in the comments field. Note whether sampling occurred downwind from site disposal or other activity that could affect sample results. Record the names and affiliations of all observers and have all sampling team members write their name and sign the Field Information Forms.

#### 3.4.3 Sampling Certification

On the bottom of the Field Information Form, the sample team leader must sign the form certifying that the sampling procedures were in accordance with applicable site permits, Federal and State regulations, and Corporate policy as outlined in this Guide and the approved monitoring plan. The person(s) providing the sampling certification assumes full responsibility that the sample process satisfied the above criteria.

#### 3.4.4 Maintenance Conditions at Well

The condition of the well and its surrounding area must be observed and problems and changes recorded on the Well Condition Inspection Form upon arrival at the well location. This form is included in Attachment 3. Conditions that may affect sample integrity, such as a damaged well casing, should also be recorded on the Field Information Form. The following information, at a minimum, should be observed on the Well Condition Inspection Form:

Presence and condition of the well's identification sign,

Whether the well was recently painted,

Whether the well's protective casing is locked and whether the key works,

Well functionality and integrity:

- Physical surroundings (e.g. high weeds, standing water, cleanliness, nearby activities)
- Condition of the bladder pump and appurtenances
- Any obstructions or kinks in the well casing
- Prolonged or excessive turbidity of evacuated water
- Poor recharge during purging
- Any presence of water in the annular space
- Any grease or other unnatural substances on the top of the well or the threaded caps
- Whether the cap fits securely to prevent the introduction of contaminants
- Evidence of natural sources for degradation (e.g. animal or insect parts in the well)
- Well guard post and concrete pad condition
- Any other condition that may be indicative of well maintenance or performance problems

Notify WM immediately of any conditions that would prevent, or preclude sampling or affect sample integrity. Upon completion of the sampling event, provide the Well Condition Inspection Form to the responsible on-site Manager. It is the responsibility of sampling personnel to notify the responsible site manager of well maintenance or well condition problems. If such conditions persist over more than one monitoring event, contact the WM Groundwater Protection Program manager.

Wells should not be sampled if it is suspected that the integrity of the well has been compromised either due to damage, natural conditions or tampering. If these conditions exist, contact the responsible on-site manager and WMI Groundwater Protection Program manager.

### **3.5 Field Measurements**

#### **3.5.1 Static Water Level Measurements**

The depth to water and elevation of the water level (MSL or permit/regulatory specified datum (i.e. NVGD)) should be recorded to the nearest hundredth of a foot (i.e. 0.01-ft). Water levels should be collected on the same day prior to purging to produce a representative static groundwater elevation contour map. To alleviate potential errors, previous water level data should be used for comparison purposes during field activities. Water levels are preferably collected prior to purging any well and as close, temporally, as possible, to minimize interference due to drawdown or barometric pressure effects.

#### **3.5.2 Depth of Well Measurements**

Biennial total depth measurements are recommended for wells with dedicated pump systems or non-dedicated equipment, or as specified in the facility permit. The total depth of the well should be measured more frequently in wells where there is visible/significant turbidity, or when tampering is noted. The well depth measurements should be compared to the pump intake depths. The pump intake should be located at the middle of the screen or lower, depending on the screen length and well recharge characteristics, maintaining a minimum of two feet (where possible) between the pump intake and the bottom of the well. However, it is the sampling team's responsibility to notify WM if there is suspicion that the pump location within a well is not appropriate for collecting representative samples. The WM representative or designate (i.e. sampling team) is responsible for evaluating and responding to excessive sediment accumulation and/or pump placement adjustments. Total depth measurement can stir up settled solids, so these measurements should be taken AFTER routine sampling is completed or at some time other than the routine sampling event to prevent high bias/false positive results.

#### **3.5.3 Additional Measurements**

Well casing stickup length (feet), well casing diameter (inches), and material of construction must be recorded on the Field Information Form. The stickup length should be verified, as required, biennially, or if a change in the immediate surroundings has occurred. The condition of flush-mounted wellhead covers and locks must also be recorded after every sample event. Other items that should be noted include; any physical alterations to the well, any alterations to the surrounding soils and associated drainage, or any other notable changes in conditions near the well.

## 4.0 GROUNDWATER SAMPLING PROCEDURES

### 4.1 Purging Procedures

After the necessary initial field measurements/observations are made and the depth to water has been determined from every well, the purging process can begin. Purging should begin with wells with the least potential for detections or wells with the lowest historical detections. The designated representative of WM will define the proper method for the disposal of purge water. In some cases, purged water should be discarded to the ground far enough away from the well footing to prevent the possibility of affecting shallow soils or groundwater near the well. Permit conditions or results from previous sampling events may prevent disposal of purge water to the ground. If purge water is deemed degraded by previous testing, it may be necessary to collect all purge water in drums (preferably lined) to dispose of them in the site leachate collection system or other approved manner as defined by WM's Project Manager and State/Local regulation.

#### 4.1.1 Procedure using Low Flow/Minimal Drawdown Purging Techniques

Low flow or minimal drawdown purging is the preferred procedure at WM facilities. The purpose of using low flow rates during low-flow purging is to avoid mobilization of formation solids. The objective of low flow purging is to obtain a representative sample, taking into consideration aquifer heterogeneities and site-specific subsurface conditions, without imparting bias due to excessive pump rates. This technique is premised on minimizing drawdown of the aquifer and stabilization of field parameters prior to and during sample collection. Pump flow rates should be selected to approximate the yield of the well, so that a stabilized pumping water level is achieved as quickly as practical, in order to then expedite the stabilization of the indicator parameters.

Minimal drawdown procedures should consist of evacuating the total volume of groundwater present in the sampling system to clear the well pump, tubing, and flow cell, if used, of any stagnant water left from prior sampling events. In general, a minimum of one (1) volume of the sampling system (i.e. pump, associated tubing, flow cell, etc.), must be purged. The maximum flow rate is determined by pumping at a rate, which allows for stabilization of the water level surface within the well. Field measurements, as described in Section 4.2.2, should be initiated at the start of purging and continued at evenly spaced intervals until stabilization. Measurements of the indicator parameters must be taken at a frequency based on the time it takes to purge one (1) volume of the pump, associated tubing, and flow cell. For example, if the volume of the pump, associated tubing, and flow cell is 500 mL and the well is being purged at 250 mL/minute, the pump, associated tubing, and flow cell will be purged in two (2) minutes. Therefore, measurements must be taken at least two (2) minutes apart.

Once stabilization has been achieved (see Section 4.2), sampling can be conducted at the same rate. Some States have maximum allowable flow rates for certain analyses (i.e. less than 1.0 liter/minute). It is the sampling team's responsibility to ensure that all State and site-specific requirements are followed. If necessary, approval from the regulatory agency should be obtained, prior to implementing minimal drawdown sampling procedures.

#### 4.1.2 Traditional Purging Methods

When minimal drawdown techniques are not utilized, monitoring wells should be pumped or bailed prior to sample withdrawal to prevent collection of non-representative stagnant water in a sample. As a general rule, pump or bail a minimum of three times the volume of water standing in the borehole (for moderate-to high-yield formations) and at least one borehole volume (including the filter pack volume, assuming 30% effective porosity, if applicable) for low-yield formations (those with slow recharge), if possible. Well purging should be sufficient to increase the likelihood that the water collected is representative of the groundwater within the formation around the well. Purging should continue, when possible, until field parameters (including pH, temperature, and electrical conductivity) have stabilized (see Section 4.2). Purge volume tables are presented in Attachment 4.

#### 4.1.3 Very Low Yield Sampling Methods

In lithologies where minimal drawdown or traditional purging methods are not feasible due to very low yields, minimal purge sampling is the preferred procedure. Please note that sampling should be avoided under these conditions because the collection of representative samples is problematic. Often wells, which cannot be stabilized using low flow purging procedures, are defined as dry wells and considered unsampleable. However, if the well must be sampled minimal purgesampling is preferred over purging dry. Minimal purge sampling involves sampling the water present in the screen zone, thereby avoiding the pitfalls of well evacuation (i.e. high turbidity) and providing the greatest chance of obtaining representative samples for inorganic and metal analytes. If necessary, approval from the regulatory agency should be obtained, prior to implementing minimalpurge sampling procedures.

NOTE: This sampling procedure is not appropriate where landfill gas may be present in the well since VOCs in the gas will tend to partition to the water phase and bias the sample. If landfill gas is present in the well, an alternate sample collection program should be developed in consultation with the WM Groundwater Protection Program Manager.

When using a dedicated pumping system (as opposed to a specialized sampler), the minimal purge approach requires the removal of the smallest possible purge volume prior to sampling, generally limited to the volume of the sampling system (pump and tubing). After removing this combined volume, samples are taken from the subsequent water pumped. Since minimal purge sampling requires the minimum possible disturbance to the water column and surrounding formation, dedicated sampling systems are required for this approach.

The pumping rates used for passive sampling are much lower than for low-flow purging, generally 100 ml/minute or less. Drawdown is expected, since it cannot be avoided; however, it is still advisable to pump at the lowest possible rate to limit drawdown to the extent possible. As with low-flow techniques, the water level in the well should not be lowered below the top of the screen, if possible.

Generally, WM does not recommend sampling a well after purging to dryness; however, it may be acceptable under certain circumstances or where necessary based on site geology and State requirements. If a well is pumped dry, it may result in the sample being compromised by

sediment or by water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. In cases where a site is required to sample a well after purging to dryness, bail or pump the volume of water standing in the well and allow the well to recharge for up to 24 hours or as stipulated by local or State regulation. If there is not sufficient water for sampling then the well should be considered dry for the purpose of sampling. WMI should be notified if this condition exists so that appropriate changes to the site monitoring plan can be made. If water is available to partially complete sampling requirements, samplers should confer with WMI's Groundwater Protection Program manager and samples may be obtained in the order specified in the approved monitoring plan or as specified by the WM Project Manager (VOAs should be collected first, followed by the remaining parameters, do not collect excessively turbid samples, see section 4.2.1). Contact the laboratory for minimum testing volumes for each analyte. If a sample cannot be obtained from a given well which normally provides adequate water for a sample, notify the WM Project Manager immediately and note appropriately on field forms.

## **4.2 Sampling the Well**

The following section describes standard procedures for collecting samples from wells subsequent to purging activities. Methodologies for the collection of field measurements, field filtered samples, and Field/Equipment and Trip Blanks are also presented.

### **4.2.1 When Not to Sample**

During a sampling event, all scheduled wells must be sampled, except in the following cases:

- If the well has been destroyed or otherwise rendered unsampleable (e.g. casing broken off or severely bent so as to preclude sampling)
- If the well is dry (see above definition in Section 4.1.3) or frozen
- If the well is new and has not been properly developed (pH, temperature, and specific conductance must be stabilized, turbidity minimized, and drilling effects eliminated from the well)
- If the well has extreme turbidity or very high settleable solids

Turbid groundwater samples are not representative of natural conditions and are a concern during sampling. Wells that consistently yield turbid samples should be replaced or rehabilitated such that low-turbidity samples can be obtained. Pending replacement or rehabilitation of the wells, turbidity should be reduced by allowing solids sufficient time to settle, as allowed by regulation, then collecting samples in a manner that minimizes sample turbidity. Consideration should be made for obtaining both filtered and unfiltered samples in turbid wells. The WM representative should be notified immediately if any well yields excessively turbid samples or if a well cannot be sampled.

### **4.2.2 Field Measurements**

Field measurements must be collected in accordance with all Federal, State or local regulations and/or permit requirements, see Attachment 5, Field Parameter Calibration Procedures. At a minimum, field measurements for pH, electrical conductivity, and temperature must be collected at each sample point during purging and as required for sampling. It is strongly recommended that dissolved oxygen or redox measurements be collected when using minimal drawdown sampling techniques.

Purging must be continued until the final three consecutive measurements for each parameter agree to within 10% of each other prior to sample collection, or as specified in the approved facility monitoring plan and/or permit (closer agreement for pH ( 0.1), specific conductivity, ( 3%), dissolved oxygen (0.2 mg/L) and redox (10 mv) may be required). Measurements should be taken at appropriate intervals (based on total volume to be purged) during the purging process to determine stabilization. Measurements must be recorded on the Field Information Form, during purging. Electronic data from a data logger used in conjunction with a flow cell can be substituted for hand recording data, provided that it is approved by the WM Representative and applicable Regulatory Agency. Multiple pages can also be used when necessary. All extra pages or electronic records must be copied and reported as designated by the WM representative. (In the case of low-flow purging, additional data can be managed electronically or separately). All pH meters must provide a reading to the nearest hundredth [e.g. 7.14]. When field measurement errors occur, a line should be drawn through any error or correction, and the entry initialed and dated (this applies to all errors, on any of the field forms or chain-of-custody records, See Section 3.3).

If the values obtained are not within the normal ranges, as indicated on previous Field Information Forms, determine if the readings are the result of inadequate purging, instrument malfunction, or a change in the character of the groundwater. The instruments should be recalibrated. If there appears to be a change in the character of the groundwater, notify the WM Project Manager, who may request that additional samples are collected to ascertain the cause of the abnormal readings. All calibration information must be documented.

Groundwater samples should be collected in the shortest possible time subsequent to purging the well. Exceptions can be made, with WM approval, to allow sediment to settle out in turbid wells. However, such wells may need to be redeveloped prior to the next sampling event. The method to be used for sampling is usually the same as that used for purging, unless otherwise specified by site conditions or regulation.

#### 4.2.3 Sample Filtration

When sample filtration is required, the samples should be filtered in the field. Only with explicit approval from the WM representative, can filtering be performed by the laboratory upon receipt. Field filtering is to be conducted at all WM sites unless otherwise specified by local and/or State regulation, the site permit, or the approved groundwater monitoring plan for the facility. Samples that require filtering must be filtered through a 0.45 micron membrane pressure filter, unless regulatory requirements specify otherwise.

Typically, only samples for dissolved metals analysis require filtration. Regulatory and permit requirements will generally specify whether to analyze, for example, for "total" metals as opposed to "dissolved" metals. WM's policy is to filter all groundwater samples for heavy metals analyses unless otherwise specifically prohibited. Surface water and leachate samples are not filtered unless specifically required by permit. Samples, which have been field filtered must be noted by the sampling team on the field Chain-of-Custody Records in the column labeled "Remarks" (see Section 7.5). Filter size, brand name, and method should also be specified on the Field



Information Form (see Section 3.4.1) Specific filtering instructions are included on the Laboratory Contract Addendum, the approved Groundwater Monitoring Plan, and in some cases the site's operating permit. Furthermore, the laboratory should note which samples require filtering on the individual bottle labels and bottle schematics.

It is recommended that all filtration be performed using an in-line filtration system. A minimum of three pump cycles of water must be allowed to pass through the filter before obtaining a sample. A new filter shall be used for each individual sample point and each sampling event. Under no circumstances are filters to be re-used. If samples are collected utilizing bailers, pressure filters are an acceptable method of filtering. The use of vacuum filtration devices is prohibited without approval of the WM Groundwater Protection Program manager. Where in-line filtration is not possible, pre-filtration bottles may be used to transfer the samples to the field filtration device. Pre-filtration bottles must be obtained from the laboratory with the sample coolers and identified at the time of initiating the bottle request. The sampling team must notify the laboratory ahead of time to arrange for sufficient number of extra bottles

**Additional Notes:**

- Filtering should always be performed during sample collection while in the field.
- Filters must be 0.45 microns and dedicated for groundwater only. Do not use any filtering apparatus that is used for other procedures such as TCLP.
- Surface water and leachate samples are never filtered unless specifically required by permit.
- Pre-filtration bottles used for pressure filtering, should not be used for more than one well. If re-use is absolutely necessary, pre-filtration bottles must be thoroughly decontaminated between wells in accordance with Section 3.1.4 of this Guide. The use of pre-filtration bottles as transfer vessels must be noted on the Field Chain-of-Custody Record in the "Remarks" column.
- Filtering of preserved samples should never be performed.

**4.2.4 Filling Sample Bottles**

Sample bottles should be filled directly from the dedicated bladder pump, or filter apparatus with minimal air contact. Volatile Organic Analyses (VOA) and Total Organic Halides (TOX), and alkalinity bottles should be headspace-free (i.e. no air bubbles in the sample bottle).

When filling the sample bottles, the following procedures and precautions should be adhered to:

1. Bottle caps should be removed carefully so that the inside of the cap is not touched. Caps should never be put on the ground. Caps for VOA vials must contain a Teflon lined septum. The Teflon side of the septum must be facing the sample to prevent degradation of the sample through the septum.
2. The sampling team should wear appropriate non-powdered surgical latex or blue nitrile gloves (PVC/vinyl gloves have a potential for trace levels of phthalate or vinyl chloride). Gloves should be changed between wells or on a more frequent basis. Gloves should also be changed any time the sampler leaves the well head area and contacts other equipment, e.g., starting or servicing a compressor or generator.

3. Tubing or hoses from the sampling systems must not touch or be placed in the sample bottles nor should tubing or hoses touch the ground; an empty cooler or stable flat surface placed by the well head can assist in facilitating this requirement.
4. After filtering, sufficient space should be available in the sample bottles for the addition of required preservatives (see Section 7.1 of this Guide). The bottle caps should then be replaced tightly.
5. TOX, alkalinity and VOA vials must be filled so that they are headspace-free. These sample bottles, therefore, need to be slightly overfilled (water tension will maintain a convex water surface in the bottle). The caps for these bottles should be replaced gently, to eliminate any air bubbles in the sample. These bottles must then be checked by inverting them and tapping them sharply with a finger. If any air bubbles appear, open the bottle, add more water, and repeat this process until all air bubbles are gone. Do not empty the bottle and refill it. VOA vials already contain preservatives (see Section 7.1). TOX bottles should have preservative added just prior to sampling, due to the headspace-free requirement. Do not overfill any containers that have been pre-preserved for any reason. Do not add additional preservatives to these bottles.
6. Sample bottles, caps, or septums that fall on the ground should be discarded and new pre-cleaned bottles used. In the event new bottles are not available, before filling the bottle, it must be thoroughly rinsed with sample water before being used. All circumstances regarding dropped caps or bottles, and their subsequent rinsing and use, must be noted on the Field Information Form.
7. The sampling team must collect a sufficient volume of liquid to allow for analysis of all required parameters. In the event that an insufficient volume of water exists for collection of the requisite suite of samples, the sample collection order specified in the site's monitoring plan or as specified by the WM Project Manager should be followed.
8. The sequence of filling bottles should ensure that samples are representative of natural groundwater conditions. This is accomplished by evenly distributing the discharged water (or bailer contents) amongst containers by analyte type (i.e. leachate indicator parameters, metals, major cations/anions, etc). For example, all sample bottles designated for analysis of major cations and anions should be filled prior to proceeding to sample bottles for another analyte type.
9. Under no circumstances should bottles (sample or Pre-filtration) or caps not supplied by the laboratory be used for any sampling.
10. Sample coolers should be present at all sample locations and should be equipped with pre-chilled, double-bagged ice packs for immediate placement of sample bottles subsequent to collection.

#### 4.2.5 Quality Assurance; Trip, Field, Equipment Blanks and Duplicates

Trip Blanks, Field Blanks and Equipment Blanks are used to detect constituents that may be introduced in the field (either from the atmosphere or from sampling equipment), in transit to or from the sampling site, in bottle preparation (Quality Assurance), or sample storage at the laboratory. Duplicates are used to confirm analytical results from a given sample point (Quality Control). Upon return to the laboratory, Trip Blanks, Field Blanks, Equipment Blanks and Duplicates will be analyzed using the same laboratory procedures and methods that are used for the collected field samples.

#### 4.2.5.1 Trip Blanks

Trip Blanks are samples of volatile organic-free, laboratory quality water (e.g. Type II reagent grade) that are prepared at the laboratory. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Trip Blank sample bottles are not opened at any time during this process. Trip Blanks are to be reported in the laboratory results as separate samples, using the designations TB- (#) as their sample point designation. If Trip Blank sample bottles are accidentally opened, note this fact on the Field Chain-of-Custody Record.

The frequency of analyses for both trip blanks and field blanks should be in accordance with the facility's permit requirements. If the frequency is not specified, then a minimum of one Trip Blank per cooler (that contains at least one VOA field sample) is recommended for WM sites (or as stated in the approved site groundwater monitoring plan). Generally, each sample cooler that includes groundwater samples for volatile organic analyses should include a Trip Blank; however, this number may be reduced. When volatile organic analyses have been requested, the sample cooler will contain a Trip Blank regardless of whether a request has been placed for analysis of the Trip Blank.

#### 4.2.5.2 Field Blanks

Field Blanks are prepared in the field (at the sampling site), using laboratory-supplied bottles and the deionized or laboratory reagent quality water. Each Field Blank should be prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. The well at which the Field Blank is prepared must be identified on the Field Information Form along with any information/observations that may explain any anomalous results (e.g. prevailing winds, upwind sources of potential degradation, etc.). Once a Field Blank is collected, it is handled and shipped in the same manner as the rest of the samples. If filtration is conducted, but not in-line, the de-ionized or laboratory quality water is exposed to air, poured into pre-filtration bottles, filtered as required, and placed in the Field Blank bottles, with the proper preservative subsequently being added.

Field Blank results will be reported as separate samples; use the designations FB- (#) as their sample designation point. The frequency of analyses for both trip blanks and field blanks should be in accordance with the facility's permit requirements. If the frequency is not specified, then a minimum of one Field Blank for every 10 sampled wells, or one Field Blank per day if less than ten wells are sampled, is recommended. Equipment Blanks can be substituted for Field Blanks with WM approval.

#### 4.2.5.3 Equipment Blanks

Equipment Blanks are required for all sampling events where non-dedicated downhole (i.e. portable pumps or bailers) equipment may contact the sample. In some cases, if an Equipment Blank is required, a Field Blank is not collected to reduce analytical costs. Decontamination procedures for non-dedicated equipment are outlined in Section 3.2 of this document. Equipment Blanks for non-dedicated equipment are collected by pouring the deionized or laboratory reagent quality water into or over the sampling device (e.g., the bailer) after it has been properly

decontaminated, then pouring the sample into the Equipment Blank bottles. The well at which the Equipment Blank is prepared must be identified on the Field Information Form along with any information/observations that may explain any anomalous results (e.g., equipment type, prevailing winds, upwind sources of potential degradation, etc.). Equipment Blanks should be filtered if appropriate for the analytical method. Non-dedicated sampling equipment blanks should be analyzed for all analytes. Whether or not the sample is filtered, this water should be placed into the Equipment Blank bottles, and the proper preservative added (as required). As in the case of Field Blanks, VOA sample bottles will be pre-equipped with preservatives.

Equipment Blank results will be reported as separate samples; use the designations EB- (#) as their sample designation point. A minimum of one Equipment Blank for each day that monitor wells are sampled is recommended.

#### 4.2.5.4 Duplicates and Split Samples

Duplicate samples are collected in the field using a matching set of laboratory-supplied bottles and sampling from the selected well on an as-requested basis. Each Duplicate should be sampled by alternating between the regular sample bottles and the duplicate sample bottles, proceeding in the designated sampling order (i.e. VOAs first). Duplicates should not be physically different in color, turbidity, or other physical parameters. The well at which the Duplicate is collected must be identified on the Field Information Form along with any information/observations that may explain any anomalous results (e.g. physical differences between samples, prevailing winds, upwind sources of potential degradation, etc.). All duplicates should be blind (i.e. the well designation is not listed on the chain of custody). Once a duplicate is collected, it is handled and shipped in the same manner as the rest of the samples.

Duplicate results will be reported as separate samples; use the designations DUP- (#) as their sample designation point. Duplicates will be analyzed on request only.

Split Samples are collected when co-sampling of a well is conducted with a third party (i.e. Regulatory Agency or External Consultant). Split Samples should be collected using the same method as a Duplicate, alternating between sample bottles, and proceeding in the designated sampling order. The well at which the Split Sample(s) is collected must be identified on the Field Information Form.

**NOTE:** When samples are split with regulatory agencies, document appropriately on the Field Information Form the condition of the bottles or preservatives, sample collection methods if different from the WM standard, and the selected agency laboratory.

## 5.0 SURFACE WATER SAMPLE COLLECTION

This section of the Guide is applicable to sampling surface water from sources such as discharge points, rivers, streams, ponds, and lakes. Prior to commencing with surface water sampling activities, Field Information Forms for each sample location should be initiated. The sampler should note any areas of dead or distressed vegetation, odors, discolored water, oily sheen, weather conditions, wind direction, nearby activities, etc. Field measurements for pH, electrical conductivity, and temperature must be collected at each sample point prior to sampling, unless otherwise specified in the approved monitoring plan or on the laboratory information sheets. All results must be recorded on the Field Information Form.

The location of the sample point should be selected with care to ensure that a representative sample of water is obtained for testing. The sample point should be selected to avoid intrusion of bottom sediments into the sample container. Samples collected from shallow depths can readily be obtained by merely submerging the sample container below the water surface. The container mouth or opening should be positioned such that the mouth faces in a downstream direction if flowing water is encountered. The sample container should be lowered into the water while still capped, uncapped under water to allow the sample bottle to fill, and re-capped before removal from the water. Pre-preserved bottles should not be filled by dipping. The sampler should wear gloves, and when necessary, stand in a downstream position to prevent any sources of cross contamination and sediment disturbance.

When sampling consecutive points in streams of flowing water, sampling should begin in the furthest downstream location and proceed in an upstream direction. In separate channels or water bodies, the locations expected to exhibit the greatest impacts should be sampled last. To ensure that the surface water samples are representative, samples should be collected from the center of the stream or body of water when possible, and at mid-depth.

Should samples be collected from a boat, the sampler must take care to avoid collection points where the turbulence caused by the propeller or by the oars has disturbed the characteristics of the water. Such samples should be collected from the lower half of the water column of the surface water body.

Surface water samples are not to be field filtered unless specified under local and/or State regulations or as otherwise stated in the sites operating permit or approved Groundwater Monitoring Plan. Sample filling techniques and preservation should follow those described in Section 4.2.4 and 7.1 of this Guide, respectively.

Some permits, such as NPDES Discharge Permits and/or State and Federal Regulations, have specific methods that are approved for field and laboratory analyses. The program manager should ensure that the sampling program and protocols are in compliance with all permit-specific field methods for storm water sampling (e.g. pH measurements in the field at the time of sampling).

## 6.0 LEACHATE SAMPLE COLLECTION

This section of the Guide is applicable to sampling fluids from leachate wells, leachate manholes, and/or leachate retention basins. Prior to commencing with leachate sampling activities, Field Information Forms for each sample point should be initiated. Upon arrival at the sample location, the general condition of the sample location and its surroundings should be recorded on the Field Information Form. The sampler should note any obvious odors in the vicinity of the sample point, foaming, discolored surface fluids, weather conditions, wind direction, nearby activities, leachate color, etc.

All leachate sampling equipment must be dedicated to each sample point or must be disposable. Fluid level measuring equipment used at leachate monitoring points should never be used at groundwater monitor points. Leachate fluid levels should be measured prior to sample collection. Field measurements for pH, electrical conductivity, and temperature must be collected at each sample point prior to sampling, unless otherwise specified in the approved monitoring plan or on the laboratory information sheets. All results must be recorded on the Field Information Form. Leachate risers and manholes do not require purging prior to sample collection. Samples should be collected using dedicated pumping equipment or by gently lowering a dedicated or disposable bailer into the sampling location and transferring the collected liquid into the sample bottles. Sample filling techniques are described in Section 4.2.4 of this Guide. Leachate samples are not to be field filtered unless specified under local and/or State regulations or as otherwise stated in the sites Operating Permit or Groundwater Monitoring Plan.

Special care should be taken when preserving leachate samples with acid since a violent reaction may occur. Acid should be added slowly and carefully to the leachate samples to avoid a violent reaction. The pH of the leachate sample should be checked prior to shipment and acid should be added to counter the buffering capacity of leachate when appropriate. The amount of preservative added should be identified on the Chain-of-Custody Records. Sample filling techniques and preservation should follow those described in Section 4.2.4 and 7.1 of this Guide, respectively. Leachate samples should not be placed in the same coolers used for shipping groundwater, residential, water supply well samples, or other typically non-degraded samples.

## **7.0 SAMPLE PRESERVATION, STORAGE, AND SHIPMENT**

### **7.1 Sample Preservation**

In general, sample preservation should be performed in the field (except for pre-preserved VOA vials). Only with explicit approval from the WM representative, can functions be performed by the laboratory upon receipt. Samples are to be preserved immediately after filtering or immediately after sample collection (if samples are not filtered). VOAs, which are allowed no headspace (no air bubbles trapped in the sample), will have proper preservatives included in the sample bottle. TOX sample, which also must be headspace-free, should have preservative added just prior to sample collection and like any pre-preserved container must not be over filled.

Bottles will be provided with preservatives in small, labeled vials and packed in a separate plastic bag and labeled as such, except in cases of VOA vials, which are pre-preserved. If required, the preservatives should be added to the sample bottle after it has been filled with the sample. The sample bottle should be filled to within 1/2 inch of the top of the sample container. Subsequent to filling, the sample shall be properly preserved. Once the preservative has been added and the sample container capped, the sample container should be inverted to ensure complete mixing with the sample. The sample container is not to be shaken. Preservation of the samples may be checked in the field periodically to ensure that the sample is properly preserved.

Unused preservative or unused, pre-preserved sample bottles should be returned to the laboratory for reconditioning or disposal.

### **7.2 Temperature Control**

The sample container and samples should ideally be cooled to 4 degrees Celsius from the time the sample is collected through the time of analysis. Samples should be maintained in temperature-regulated refrigerators, in coolers, or in sample coolers containing double bagged or commercial frozen wet ice packs. It is the sampler's responsibility to ensure that provisions have been made in advance for facilities that do not have accommodations to freeze the wet ice packs. In such cases, it is recommended to bring pre-chilled coolers and extra ice packs to the site. The ice packs should be frozen solid prior to use. It is the sample team leader's responsibility to ensure that the samples are properly cooled during shipment to the laboratory. Blue ice or chemical ice packs should not be used, unless specified or required by the WM Representative or lead Agency.

### **7.3 Sample Packing and Storage**

#### **7.3.1 Checking Sample Designations and Numbers**

Prior to packing the sample bottles into the shipment coolers, the sampling team must record the sample designations in the appropriate spaces on the Field Chain-of-Custody Records and Field Information Form. It is important that the proper designations be recorded in the proper space on the form and that they be double-checked before sealing the sample cooler.

All bottles filled from the same sample point at the same time must have identical sample designations (except Field Duplicates). Samples that are split with regulatory agencies should also be checked for consistent sample point designation numbers and for other methods of identification used by the agency.

#### 7.3.2 Sample Packing

After the sample is collected and the preservatives are added (when applicable), the bottles should be capped and placed in the sample cooler. The frozen ice packs should be placed into the sample cooler such that they are not in direct contact with sample bottles. Glass containers should not be packed in contact with each other. Bottle holders/cushions and/or bubble wrap should be used for glass bottles to protect them from potential breakage. Do not overpack the coolers with samples. Do not ship leachate or other highly impacted samples in the same cooler as groundwater or surface water samples.

All bottles should be wiped clean with paper towels before placement in the sample cooler. The sample cooler must be kept as clean as possible to minimize the potential for degradation. All bottle caps should be checked to ensure they are tight and will not become loose when inserted in the sample cooler. Bottle caps should not be taped. Labels should be taped only if they are loose, and this should be noted on the Field Information Form or Chain-of-Custody Record.

The Field Chain-of-Custody Records (see Section 7.5) and Field Information Forms must then be reviewed to ensure that they have been completed properly. All original paperwork (white copies) should be placed in a plastic bag, sealed, and placed inside the sample cooler or taped to the inside lid of the cooler. The sampling team should maintain a copy of all Chain-of-Custody documents and Field Information Forms for verification purposes (pink copies). Copies (yellow) should be maintained at the facility.

The sample cooler should be taped and sealed. Custody seals, when provided, should be initialed and dated by the sampling team and placed across the front opening of the cooler. The shipping company should not sign the Chain-of-Custody or the custody seals.

#### 7.3.3 Sample Storage

Samples should be stored at 4 degrees Celsius, in an enclosed cooler or dedicated refrigerator where possible, before shipment to the laboratory for analysis. Samples should be shipped daily to the laboratory to ensure proper temperature control and holding time requirements are met.

### **7.4 Sample Shipment**

Samples must be shipped to the laboratory as soon as possible, such that there is no exceedence of holding times. Due to the extremely short hold and extraction times involved with many of the methods used at WM sites, all samples with short holding times (e.g. nitrates, coliform) shall be shipped on the same day that the samples are collected. It is the sample teams' sole responsibility to ensure expedient delivery of samples to the laboratory, such that the samples arrive at the laboratory at the proper temperature and well within the range of specified holding times.



A member of the sampling team must be appointed to arrange sample pickup and/or transportation to the laboratory. Friday shipment of samples to the laboratory should be avoided to ensure that holding times are not exceeded over a weekend. Delivery requested on Saturday must be noted specifically on the shipping/packing air bill for the courier. The laboratory must be notified at least 48 hours preceding the anticipated delivery. In the event of a holiday, contact the laboratory in advance for shipping instructions.

Sample coolers are to be returned by the sampling team using the laboratory designated shipper and shipping labels (i.e. Airborne, Federal Express, United Parcel Service), unless delivery service by the laboratory specified shipper is not available at the facility. The WM representative and laboratory contact should resolve any return shipping issues (i.e. service, rush service availability) prior to sample delivery. In the absence of such specification, the WM representative should determine the shipment method.

When contacting the courier for transport of a sample, specify the sample cooler contents. Alert the courier to the potential problems of the samples freezing in the winter or ice packs melting in the summer, and note these potential problems on the shipping/packing label. Sample coolers should be received at the laboratory within 24 hours of when the frozen ice packs were placed in the sample cooler (with the exception of Alaska and Hawaii). This is necessary for temperature preservation and to meet required holding times for some analyses. Any necessary delay in shipment of the coolers to the laboratory must be documented on the Field Chain-of-Custody Record, and is the responsibility of the sampling team.

#### **7.5 Sample Chain-of-Custody Record**

To help maintain the integrity of the samples, strict chain-of-custody procedures are necessary. These procedures help to ensure that tampering with the samples does not occur. From the time the sample bottles leave the laboratory until the issuance of the analytical laboratory results, the samples and/or sample containers must be in the custody of assigned WM personnel, an assigned consultant, contractor, or the laboratory. In order to maintain the chain-of-custody, the samples must be in sight of the assigned custodian or locked in a tamper-proof location. A written record of sample bottle possession and any transfers of samples must be maintained and documented on the Field Chain-of-Custody Record.

The Sample Chain-of-Custody must contain, at a minimum, the following information:

- Site Name
- Station Numbers (Line No. on COC, ascending order)
- Date Samples are collected (by sample)
- Time Sample Collected (by sample)
- Type of Sample (Composite, Grab, Groundwater, leachate, surface water)
- Number of containers per sample point
- Filtering Requirements (Remarks Column)
- Preservatives (Remarks Column)
- Analysis Required
- Special Remarks (i.e. remittance of sealed coolers via courier) (at base of Form)

The Field Chain-of-Custody Record must further be signed with the date and time for the following activities:

- Receipt of the sample cooler (s)
- Each time the sample cooler is transferred to the custody of another person
- Immediately before sealing the sample cooler for transport to the laboratory. (The form must be signed and enclosed within the cooler in a watertight bag).

Samples from the same sample point that are placed in more than one sample cooler require a Field Chain-of-Custody Record in each sample cooler. Any problems with the sample cooler's contents must also be noted on the form. Upon receipt of the sample cooler by the lab, the condition of the samples, temperature, date, and time are recorded on the Field Chain-of-Custody Record by the log-in personnel receiving the sample coolers. The Field Chain-of-Custody Record indicates by bottle and analysis group whether samples are preserved. The sampling team must record the field filtration, preservative, and any deviations from normal preservation requirements on the Chain-of-Custody Record (the sampling should initial the forms if this information is preprinted on forms provided by the lab). Failure to complete the Field Chain-of-Custody Record will render the resulting data useless. An example of the WM Field Chain of Custody Form is provided as Attachment 3.

## 8.0 SPECIAL SAMPLE COLLECTION PROTOCOLS

This Guide addresses all routine (reoccurring) sample collection activities at WM Facilities. Non-routine or special sampling is often required to collect further information. The following is a brief outline of procedures that are being developed and will be available in the event of non-routine or special sampling. These procedures will be available from the WMI Groundwater Protection Program Manager for the area.

In most all cases the WM Groundwater Protection Program should be notified of special sampling events, as they pertain to non-routine groundwater issues. The events should be conducted under the supervision of the WM Project Manager.

- **Special Event Notification:**  
Use this procedure for one time only or limited event special sampling and resample events. Notify the laboratory in ample time for laboratory response using a Special Event Notification/Bottle Request Form (Attachment 2); provide a copy of the approved form to the sampling team.
- **Field Inspection Forms:**  
Updated forms allowing for collecting low-flow data (attached)
- **WM Environmental Sampling Audit Checklist:**  
Available upon request
- **Low Flow Sampling:**  
Detailed guidance for low flow sampling procedures developed in part from EPA and QED guidance. WM has an in-house procedure that is available upon request.
- **Isotope Sampling:**  
Detailed guidance for isotope sampling procedures will be as appropriate for the Method. Protocols should be specified on a case-by-case basis with WMI's Groundwater Protection Program manager.
- **WM STANDARD GUIDE for evaluating intra-well gas to water transfer of volatile organic compounds (VOCs) at landfill sites:**  
Available upon request or on WM Visor
- **WM STANDARD GUIDE for Monitor Well/Piezometer Development:**  
Available upon request or on WM Visor
- **Leak Detection System Monitoring and Evaluation Procedures:**  
White Sheet Pending

## **ATTACHMENT 1**

**SIGNATURE PAGE (S)**

FOR INTERNAL  
USE ONLY - NOT  
FOR PUBLICATION

### SIGNATURE PAGE

The following persons have read and agree to follow the WM Sampling Guide. Exceptions to the Guide are to be noted below.

<b>SITE/LOCATION:</b>	_____	<b>Reference:</b>
<b>SITE SPECIFIC EXCEPTIONS:</b>	_____	
	_____	
	_____	
<b>SITE/LOCATION:</b>	_____	<b>Reference:</b>
<b>SITE SPECIFIC EXCEPTIONS:</b>	_____	
	_____	
	_____	
<b>SITE/LOCATION:</b>	_____	<b>Reference:</b>
<b>SITE SPECIFIC EXCEPTIONS:</b>	_____	
	_____	
	_____	
<b>SITE/LOCATION:</b>	_____	<b>Reference:</b>
<b>SITE SPECIFIC EXCEPTIONS:</b>	_____	
	_____	
	_____	

<b>SAMPLING TEAM COMPANY</b>	<b>PROJECT MANAGER</b>	<b>SIGNATURE</b>	<b>DATE</b>
1 <b>SAMPLER NAME</b>	<b>SIGNATURE</b>	<b>SAMPLER NAME</b>	<b>SIGNATURE</b>
2 <b>SAMPLER NAME</b>	<b>SIGNATURE</b>	<b>SAMPLER NAME</b>	<b>SIGNATURE</b>
	<b>SIGNATURE</b>	<b>SAMPLER NAME</b>	<b>SIGNATURE</b>
	<b>SIGNATURE</b>	<b>SAMPLER NAME</b>	<b>SIGNATURE</b>

<b>WASTE MANAGEMENT</b>	<b>SIGNATURE</b>	<b>DATE</b>
-------------------------	------------------	-------------

Multiple copies can be made for additional sites/facilities/samplers. The Sampling Team/Company should notify WM of any changes in field personnel and should forward an updated copy of this signature page prior to going into the field.

## **ATTACHMENT 2**

### **SPECIAL EVENT NOTIFICATION FORM**



**WASTE MANAGEMENT, INC**  
**SPECIAL EVENT ADDENDA**

**NOTIFICATION/BOTTLE REQUEST FORM**

Attention:	Fax No.:
Addendum No.:	Event Description: <input type="checkbox"/> Verification <input type="checkbox"/> Resample <input type="checkbox"/> Non-Routine <input type="checkbox"/> Other _____
Date Requested:	Date Bottles Required:
Site: Name: _____ Location: _____	TAT: <input type="checkbox"/> 24hr. <input type="checkbox"/> 48hr. <input type="checkbox"/> 72hr. <input type="checkbox"/> 1 week <input type="checkbox"/> Standard (21 CD)
Sample Locations: _____ _____ _____ _____ _____ _____ _____ _____	Parameters Requested: _____ _____ _____ _____ _____ _____ _____ _____
Send Bottles to: Attn: _____ Co.: _____ Address: _____ _____	
Special Instructions: _____ _____ _____ _____ _____	
Requested by: _____ Name                      Signature	Confirmed by: _____ Name                      Signature
Notes: WM should fax and confirm verbally with Laboratory Contact. Lab should return faxed copy to confirm event.	

## **ATTACHMENT 3**

**WELL CONDITION INSPECTION FORM**

**CHAIN OF CUSTODY FORM**

**FIELD INFORMATION FORM**



# WELL CONDITION INSPECTION FORM

Site: \_\_\_\_\_ Personnel: \_\_\_\_\_

Date: \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_

Well ID	Protective Casing	Well Casing	Label	Lock	Sample Equipment Type	General Turbidity	Well Yield	Comments/Observations *
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
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	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	
	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Damaged	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Clear <input type="checkbox"/> Turbid	<input type="checkbox"/> OK <input type="checkbox"/> Inadequate	

\* Note ponding water, weep holes, or any other information pertaining to well condition. Provide additional details on listed items.  
Return this form to Site Manager and Groundwater Program Manager

## Well Condition Inspection Form

Facility: \_\_\_\_\_ Well/Piezometer Name: \_\_\_\_\_

Evaluator: \_\_\_\_\_ Evaluation Date: \_\_\_\_\_

	Y	N	N / A
Is the well's location appropriately shown on a facility map?			
Is the well adequately flagged if hard to find?			
Is the well elevation information inscribed at or on the well correct?			
Is the well:			
<input type="checkbox"/> flush with surface?			
<input type="checkbox"/> above ground?			
Is the well free of physical damage?			
Is the well labeled on the inside?			
Is the well labeled on the outside?			
<b><i>Does the well have protective posts, if necessary?</i></b>			
Do above ground wells have weep holes at the base of the protective casing?			
Does the area around the well appear clean?			
Is the casing secure (attempt to move along two perpendicular axes)?			
Is the surface seal void of differential erosion around and under the base?			
Is the surface seal free of cracks that might affect the integrity of the seal?			
<b>Is the surface seal sloped to prevent ponding around the well?</b>			
Is the well free from standing or ponded water?			
Is the well locked to prevent unauthorized access?			
Is the protective casing cap void of large gaps which would breach security?			
Is the locking cap free of rust?			
Is there a survey mark on the riser/wellhead assembly cap?			
Is the riser cap vented?			
Is the annular space free of animal/insect nests?			
Is the annular space appropriately filled with filtering material?			
If a pump, can it be lifted a few inches? (do not test prior to sampling)			
Is the well free of kinks or bends?			

COMMENTS: \_\_\_\_\_



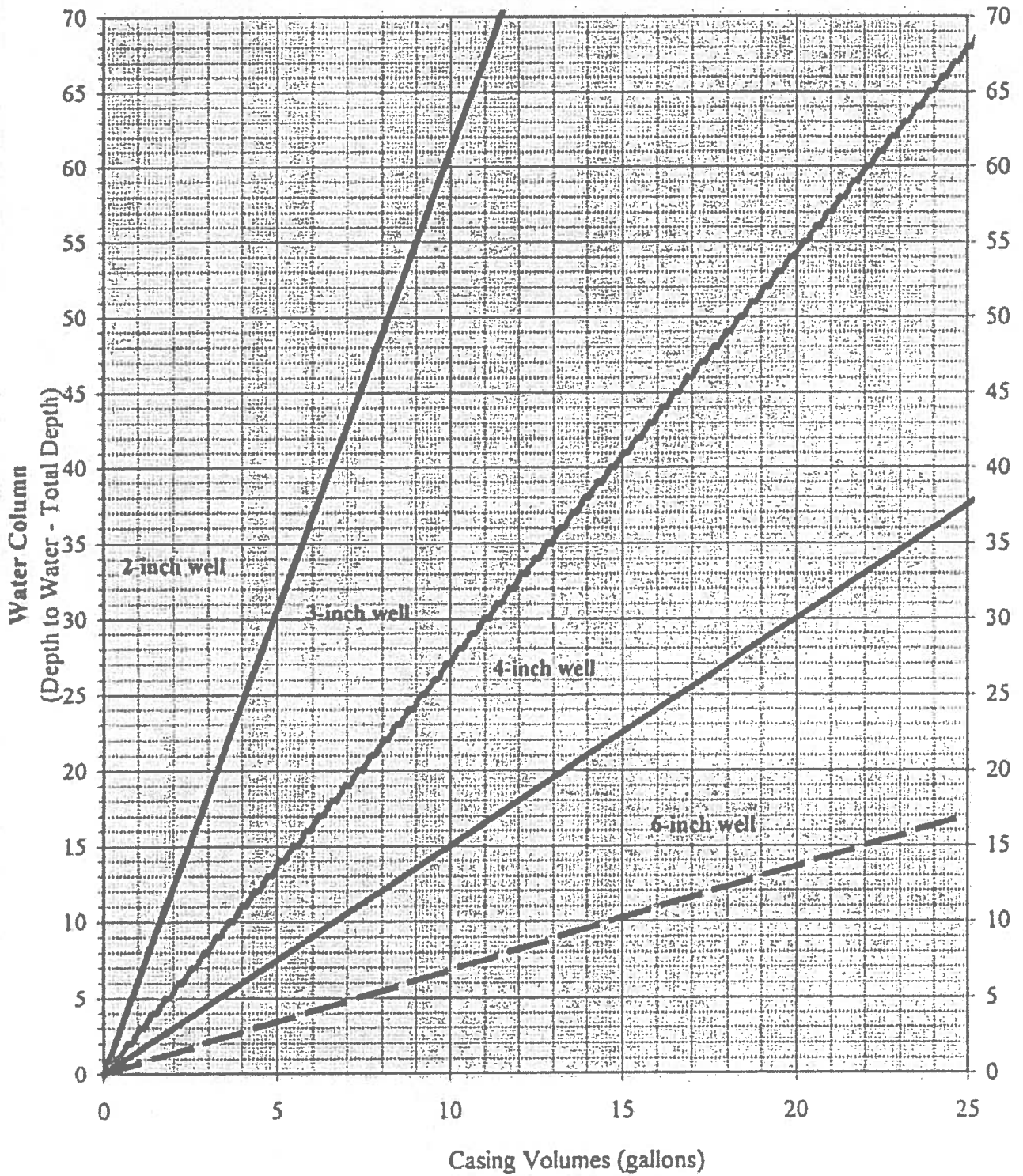
**Internal Use Only**

[illegible]

## **ATTACHMENT 4**

### **PURGE VOLUME GRAPHS**

# Purge Table



$$\text{Casing Vol [gal]} = (3.142) * ((\text{well radius [in]} / 12 [\text{in/ft}])^2) * (\text{water col. [ft]}) * 7.5 [\text{gal/ft}^3]$$

# **ATTACHMENT 5**

## **METER CALIBRATION LOG**

### **FIELD PARAMETER CALIBRATION PROCEDURES**

#### **STANDARD METHODS FOR CHEMICAL ANALYSIS OF WATERS AND WASTEWATERS**

**pH – Method 150.1**  
**Temperature – Method 170.1**  
**Turbidity – Method 180.1**  
**Conductance – Method 120.1**  
**Oxygen, Dissolved – Method 360.1**

## METER CALIBRATION LOG

PROJECT NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

PROJECT NUMBER: \_\_\_\_\_ SAMPLER: \_\_\_\_\_

MODEL: \_\_\_\_\_ SERIAL NO.: \_\_\_\_\_

### pH METER

Time	pH 10 Buffer Check	pH 7 Buffer Check	pH 4 Buffer Check	Temp of Calibration Soln (°C)

Buffer Lot Numbers: pH 4: \_\_\_\_\_ pH 7: \_\_\_\_\_ pH 10: \_\_\_\_\_

### CONDUCTIVITY METER REDOX METER

Temp. of Calibration Soln	Corrected Cond. @ 25°C	Time

Temp (°C)	E <sub>H</sub> Reading (mV)	Time

Calibration Solution Lot Number: \_\_\_\_\_ Calibration Solution Lot Number: \_\_\_\_\_  
Calibration Range for Solution \_\_\_\_\_ Calibration Range for Solution \_\_\_\_\_

MODEL: \_\_\_\_\_ SERIAL NO.: \_\_\_\_\_

### Turbidity Meter

Gel Value (NTU)	Reading (NTU)	Time
0 – 10 range		
0 – 100 range		
0 – 1,000 range		
0 – 10 range		
0 – 100 range		
0 – 1,000 range		

Problems/Corrective Actions: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

QC'd By: \_\_\_\_\_ Date: \_\_\_\_\_